Preliminary Assessment Report

San Mateo Creek Legacy Uranium Sites

CERCLIS ID NMN00060684
McKinley and Cibola counties, New Mexico

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New Mexico Environment Department
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Text by David L. Mayerson
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1.0 Introduction

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"), as amended, 42 United States Code ("U.S.C.") §§ 9601 to 9675, the New Mexico Environment Department ("NMED") Superfund Oversight Section ("SOS") has conducted a Preliminary Site Assessment ("PA") of the San Mateo Creek basin legacy uranium mine and millsites (Site), which is located in Cibola and McKinley counties, New Mexico (CERCLIS ID NMN00060684; Figure 1).

The objective of the PA is to evaluate the Site using the Hazard Ranking System (Ref. 1) and the Superfund Chemical Data Matrix (Ref. 2) to determine if a threat to human health and the environment exists such that further action under CERCLA is warranted.

2.0 Site information

2.1 Location and description

The San Mateo Creek basin (Hydrologic Unit Code ["HUC"] 1302020703), by which the boundary of the Site is defined, comprises approximately 321 square miles within the Rio San Jose drainage basin (Ref. 3, 4) in McKinley and Cibola counties, New Mexico (Ref. 5; see Figure 1). This basin is located within the Grants Mineral Belt ("GMB"), which is an area of uranium mineralization occurrence approximately 100 miles long and 25 miles wide encompassing portions of McKinley, Cibola, Sandoval and Bernalillo counties (Ref. 6, p. 8), and includes the Ambrosia Lake mining district (Ref. 6, p. 17). Main access into the Site is provided by New Mexico State Roads 605 and 509.

The 85 legacy uranium mines with recorded production and 4 legacy uranium millsites comprising the Site (Ref. 7) may have contributed to degradation of ground water quality within this basin. Some background ground water contaminant concentrations associated with remediation of the Homestake Mining Company ("HMC") Superfund Site ("HMC Site;" NMD007860935; Ref. 8) exceed Federal (Ref. 9 and 10) and State (Ref. 11) drinking water standards. Additionally, ground water quality data collected by HMC from some monitor wells that are completed in the San Andres aquifer (Ref. 12, p. 8.0-4; Ref. 13; Ref. 14) show increasing uranium concentrations, some exceeding Federal and State drinking water standards. These uranium concentrations are unlikely to be attributable to contamination from the HMC site because recharge to eastward-flowing ground water in the San Andres aquifer is west of the HMC site; vertical hydrologic communication to overlying aquifers impacted by contamination from the HMC site is limited (Ref. 12, p. 8.0-1).

2.2 Geologic setting

The southern end of the San Mateo Alluvial system has been impacted by contamination from the HMC Site. This alluvial system extends from the northeast to the south of the HMC site, following the San Mateo Creek drainage (Ref. 15, p. 2-1). Underlying the Alluvial aquifer in this vicinity is the Upper Triassic (Ref. 6, p. 12) Chinle Formation, which is a predominantly shale formation 800 feet in thickness. Three aquifer units are present within this formation in the southern part of the basin. The highest 2 aquifers are the Upper and Middle Chinle sandstones. The lowest aquifer, the Lower Chinle, is a fractured shale with variable hydrologic yield of generally poor quality water. All three of these aquifers subcrop with the Alluvial aquifer, connecting the Alluvial aquifer and each of the Chinle aquifers hydrologically in the vicinity of the Homestake site. The San Andres regional aquifer underlies the Chinle Formation in this area (Ref. 15, p. 2-1—2-2).

Most uranium production in New Mexico has come from the Upper Jurassic Westwater Canyon member of the Morrison Formation in McKinley and Cibola counties (Ref. 6, p. 9; Ref. 16, p. 1, 6). This unit consists of interbedded fluvial arkosic sandstone, claystone, and mudstone with an average thickness of 250 feet, thinning to 100 feet southward and eastward, and is a major aquifer within the GMB (Ref. 6, p. 9). Three types of uranium deposits that are found in the Westwater Canyon member are primary (trend or tabular; average ore grade greater than 0.20% U_3O_8), redistributed (stack; average grade 0.16% U_3O_8), and remnant-primary (average grade 0.20% U_3O_8; Ref. 16, p. 6, 8). The overlying Brushy Basin member of the Westwater Canyon member includes the Poison Canyon Sandstone, from which uranium also has been mined (Ref. 6, p. 9, 13).

Additionally uranium deposits were discovered at Haystack Butte in 1950 within the Upper Jurassic Todilto Limestone, which occurs within the San Raphael Group underlying the Morrison Formation (Ref. 6, p. 12, 13; Ref. 16, p. 4); these accounted for approximately 2% of production from the "Grants uranium district" between 1950 and 1981 (Ref. 16, p. 11). More than 100 uranium mines and occurrences in the Todilto Limestone are documented in New Mexico, with production reported from 42 of these mines—mostly located within the "Grants uranium district" (Ref. 16, p. 12).

Thin zones of minor uranium mineralization have been produced from shale and lignite within the Lower Cretaceous Dakota Sandstone, which overlies the Morrison Formation (Ref. 6, p. 13; Ref. 16, p. 12). Uraniferous collapse-breccia pipe deposits, which are vertical or steeply-dipping cylindrical features bounded by ring fractures and faults filled with heterogeneous brecciated "country" rock, also are found in the Grants area (Ref. 16, p. 12).

Quaternary-age unconsolidated to semi-consolidated alluvial, eolian, and terrace deposits overlie bedrock in valley bottoms; these deposits are generally less than 200 feet in thickness (Ref. 6, p. 13).

2.3 Demographics

Average household size within McKinley County is 3.44 people (Ref. 17); average population density is 13 people/square mile (Ref. 18, p. 1). Within Cibola County, the average household size is 2.95 people (Ref. 19, p. 1); the average population density in Cibola County is 6 persons/square mile (Ref. 18, p. 2).

The community of San Mateo, which is located within the San Mateo Creek basin, has a municipal water supply that serves 192 residents (Ref. 20, p. 1). No demographic data for the community of Haystack were found.

The communities of Grants, Milan, and Bluewater are located just outside of the boundaries of the proposed Site. In 2000, Grants had a population of 8,806 people with average household size of 2.61 people (Ref. 21). Milan in 2000 had a population of 1,891 with an average household size of 2.81 people (Ref. 22). No population data were found for Bluewater.

2.4 Climate

The average annual maximum temperature at the Grants Airport is 67.8° F; the highest maximum temperature of 88.4° F occurs in July. The average annual minimum temperature is 33.0° F; the lowest minimum temperature of 14.4° F occurs in December. The average annual total precipitation is 10.40 inches (in.). The maximum average precipitation of 2.03 in. occurs in August; the minimum average precipitation of 0.44 in. occurs in February. Average annual snowfall is 12.3 in., with the maximum snowfall of 4.1 in. occurring in December (Ref. 23).

The average annual maximum temperature at the weather station in San Mateo, New Mexico is 61.7° F; the highest maximum temperature of 83.1° F occurs in July. The average annual minimum temperature is 34.6° F; the lowest minimum temperature of 16.0° F occurs in January. The average annual total precipitation is 8.66 in. The maximum average precipitation of 2.11 in. occurs in August; the minimum average precipitation of 0.28 in. occurs in February and December. Average annual snowfall is 9.7 in., with the maximum snowfall of 3.1 in. occurring in December (Ref. 24).

The prevailing wind direction (i.e., the direction from which the wind blows) at the Grants airport is northwesterly (Ref. 25, p. 10); however this may not be entirely representative of wind direction within the San Mateo Creek basin (Ref. 26).

At a monitoring location within Bluewater Creek (elevation 7,624 feet), the prevailing wind direction was west-southwesterly during 2007, at an average speed of 9.0 miles per hour (mph) (Ref. 27, p. 2). At a nearby monitoring location on Bluewater Ridge, the prevailing wind direction is south-southwesterly at an average speed of 4.3 mph (Ref. 28, p. 2).

2.5 Operational history and ownership

Land ownership within the area is a complex of Indian, Federal, State, and private (Ref. 29; see Figure 3).

Uranium ore was discovered in the Todilto Limestone at Haystack Butte in 1950, and production began prior to mill construction in the area by open-pit mining. Uranium was discovered at Ambrosia Lake in 1955 (Ref. 16, p. 4). Downdip drilling from the initial surface discoveries delineated ore bodies within the Poison Canyon and Westwater Canyon members of the Morrison Formation. The discovery of large subsurface uranium deposits within the Westwater Canyon member resulted in establishment of two-thirds of the active uranium mines in

New Mexico within the Ambrosia Lake district by 1980; most of these mines were underground room-and-pillar operations at depths averaging 900 feet (Ref. 6, p. 17).

The Anaconda Copper Company built the Bluewater mill in 1953 to process ore from the Jackpile mine (Ref. 16, p. 5; Ref. 30, p. 1). This mill used a carbonate-leach process with a capacity of 300 tons per day and operated until 1959. An acid-leach mill was operated from 1957 through 1982, reaching a production capacity of 6,000 tons per day in 1978 (Ref. 30, p. 1). ARCO Coal Company reclaimed the site between 1991 and 1995 for long-term DOE stewardship under the Legacy Management program (Ref. 16, p. 5; Ref. 30, p. 1-2).

Two mills were built in 1957 at the present Homestake millsite. The first closed in 1962. Homestake originally owned the second larger mill in a partnership; when that partnership was dissolved in 1981, Homestake became the sole owner. Mill production ceased in 1981, but resumed in 1988 to process ore from the Section 23 mine and Chevron's Mount Taylor mine. The mill was demolished in 1990 (Ref. 16, p. 5), and the site ground water restoration is ongoing (Ref. 12). In 2001, Homestake has merged with Barrick Gold Corporation (Ref. 16, p. 5).

Kermac Nuclear Fuels Corp., which was a partnership of Kerr-McGee Oil Industries, Inc., Anderson Development Corp., and Pacific Uranium Mines Co., built the Kerr-McGee uranium mill at Ambrosia Lake in 1957-58. Quivira Mining Co., a subsidiary of Kerr-McGee Corp. (later Rio Algom Mining LLC, currently BHP-Billiton) became the operator of the mill in 1983. Operation began in 1958; from 1985 through 2002 the mill produced only from mine waters from the Ambrosia Lake underground mines. (Ref. 16, p. 5). The tailing impoundment at the site contains 33 million tons of uranium ore (*sic*) within an area of 370 acres (Ref. 31).

Phillips Petroleum Co. built a mill at Ambrosia Lake in 1957-58, and began to process ore from the Ann Lee, Sandstone, and Cliffside mines in 1958. United Nuclear Corporation acquired the property in 1963 when the mill closed (Ref. 16, p. 5). United Nuclear Corporation operated an ion exchange system to extract uranium from mine water in the late 1970s to early 1980s. All operations ended in 1982 (Ref. 32, p. 1).

2.6 Regulatory history

Some mines are inventoried by the New Mexico Bureau of Geology and Mineral Resources, the Navajo Nation Abandoned Uranium Mine (AUM) program, and/or the U.S. Bureau of Land Management; some minesites also have been reclaimed under Federal or State jurisdiction (Ref. 7; see Table 1).

In 1978, the U.S. Environmental Protection Agency (EPA) proposed to regulate minewater discharge under the NPDES permit program. The permit for the Kerr-McGee Section 35 and 36 mines was terminated when Kerr-McGee undertook controlled spreading and irrigation with mine dewatering effluent. Kerr-McGee obtained a State ground water discharge permit for IX ion exchange ("IX") facilities associated with the Section 35 and 36 mines in 1979-1980; this permit currently is in stand-by status (Ref. 33, p. 2).

The Bluewater Mill site was remediated by the Atlantic Richfield Company ("ARCO") under the U.S. Nuclear Regulatory Commission ("NRC") operational license, and was subsequently transferred to DOE custody and long-term care in 1997 (Ref. 34) under the jurisdiction of Title II of the Uranium Mill Tailings Radiation Control Act ("UMTRCA;" Ref. 30, p. 1). Prior to this transfer, the NRC amended the operational license to include alternate concentration limits ("ACLs") for the Alluvial and San Andres aquifers, which were impacted by the site, at established point of compliance wells (Ref. 30, p. 2; Ref. 35, p. 1, 3, and 4; see Table 2).

Homestake Mining Company is currently remediating the Homestake uranium millsite under the regulation of NRC license SUA-1471 and NMED discharge permit DP-200 (Ref. 12, p. 1.1-1). This site also is on the National Priorities List ("NPL") as well (CERCLIS ID NMD007860935; Ref. 36, p. 17).

The site status of the Ambrosia Lake/Rio Algom mill was changed to reclamation in August 2003. NRC issued a license amendment for ACLs in February 2006, after which all ground water corrective actions were discontinued (Ref. 31).

The DOE remediated the Ambrosia Lake/Phillips mill site between 1987 and 1995 as part of the 1978 UMTRCA Title I program, and currently monitors the site as part of the Legacy Management program (Ref. 16, p. 5; Ref. 32, p. 1-2; Ref. 37).

2.7 Previous environmental investigation

Numerous environmental investigations associated with remediation of the 4 millsites within the Site have been conducted under the regulatory authority of the NRC; documents from these investigations are not detailed herein, but are available through the ADAMS website interface (http://adamswebsearch.nrc.gov/scripts/securelogin.pl).

The New Mexico Health and Environment Department ("EID") documented a study of the uranium mining impacts on surface and ground water within the Grants mineral belt (Ref. 6).

The New Mexico Energy, Mineral and Natural Resources Department ("NMEMNRD") has compiled a database of uranium legacy mine and mill site information from multiple sources (Ref. 7), which forms the basis of this investigation. The locations of the mines with reported production and mills from this database are shown on Figure 1 and on Table 1. Other minesites without reported production in this database are not addressed herein.

NMED sent letters to the Rio Algom Mining Company in 2005 and 2006, requiring compliance with 20.6.2.1203 NMAC for reporting soil contamination related to mine dewatering activities for the Section 35 and 36 mines (Ref. 33, p. 1).

Individual mine- and millsites within the Site boundary that have been investigated under CERCLA are summarized in Table 3.

The U.S. Forest Service has proposed CERCLA investigation of the San Mateo mine in 2008 (Ref. 38, p. 21).

3.0 Site investigation

3.1 Source/waste characteristics

Both surface and underground mining methods contributed waste to natural surface drainage systems. Liquid wastes were almost exclusively derived from underground operations, while both operational methods contributed solid wastes. Underground mines generally produce less waste rock than surface mines, but contaminant concentrations can be higher (Ref. 6, p. 19). Mine waste piles may include barren overburden, low-grade ore (i.e., below economic value), and/or ore stockpiled for later milling (Ref. 6, p. 54). The spoils areas in which this waste rock is stored usually were not bermed to control runoff (Ref. 6, p. 19). EID sampled mine wastes from minesites within the Site to test contaminant leachability (Ref. 6, p. 34-35). Leaching testing from 37 composite samples of uranium mine waste that were designed to simulate the leaching effects of natural rainfall both before and after contacting alkaline rich soils indicated that contaminants have a relatively low potential for leaching or for significantly degrading ground water quality (Ref. 6, p. 57).

A 1985 survey of 14 uranium mines located within the GMB, which includes individual minesites located within the proposed Site, on Federally-owned surface and mineral lands showed gamma radiation levels between 6 and 888 microroentgens per hour, with the highest reading taken from mine waste and openings (Ref. 39, p. 2-4; see Table 1).

Sampling results of waste rock materials from the Poison Canyon Mining District are summarized in Table 4. Nearly all contaminant concentrations in the waste materials are higher than in the background samples by one to two orders of magnitude (Ref. 40).

Waste material from the Navajo-Brown Vandever uranium mine (NMD986669117; see Table 3) was used to pave the road to this site, and approximately 75 people were identified to live with one-quarter mile of the site in 1990 (Ref. 41).

EID investigators concluded that 10 to 20 percent of all abandoned mines in the GMB had waste piles that are directly eroding into local drainage channels (Ref. 6, p. 55). EID collected runoff samples from several sites to assess contaminant input from mine waste piles within the Ambrosia Lake mining district (Ref. 6, p. 54); observations from this program indicated that runoff contaminant concentrations exceeded natural concentrations by up to several hundred times. Samples collected within the Ambrosia Lake mining district indicated that uranium and molybdenum maxima concentrations in waste pile runoff exceed natural runoff concentrations by over 2 orders of magnitude. Maximum arsenic, selenium, and vanadium concentrations exceed maximum natural runoff concentrations by 6 to 8 times (Ref. 6, p. 54-55). Runoff sampling in the vicinity of a large waste pile associated with the Old San Mateo mine showed elevated levels of gross alpha and gross beta particle activities, $radium_{226}$, natural uranium, arsenic, lead, molybdenum, selenium, and vanadium, in comparison to natural sediments, to persist at least 550 meters downstream from the waste pile (Ref. 6, p. 57).

Water produced from mine dewatering and aquifer depressuring operations was discharged to settling ponds and drainage channels (Ref. 6, p. 20-21). Mine water production within the Ambrosia Lake mining district was continuous after 1956, with peak production in the early 1960s (Ref. 6, p. 66). During the period 1979-1981, mine discharges of 1,500 gallons per minute ("gpm") to San Mateo Creek sustained approximately 3 miles of perennial flow; 2,300 gpm discharge to Arroyo del Puerto sustained perennial flow of approximately 5 miles (Ref. 6, p. 66, 68). In 1977, approximately 2,900 gpm were being discharged to San Mateo Creek from mine dewatering; by spring of 1978, most of this water was diverted for irrigation and to an adjacent drainage basin (Ref. 6, p. 72).

Minewaters generally contain higher concentrations of sodium and sulfate than natural runoff (Ref. 6, p. 84). Raw minewaters from the GMB had elevated concentrations of gross alpha and beta particle activities, $radium_{226}$, $lead_{210}$, natural uranium, molybdenum, selenium, and dissolved solids—particularly sulfate; elevated concentrations barium, arsenic, and vanadium also were observed (Ref. 6, p. 80). Total dissolved solid ("TDS") concentrations in minewaters from the western part of the Ambrosia Lake mining district were 1,200 to 1,800 milligrams per liter ("mg/l"). Minewater in eastern part of the Ambrosia Lake mining district usually had a few hundred mg/l TDS.

For compliance with federal National Pollutant Discharge Elimination System (NPDES) permits, produced waters were treated with the additions of a flocculent and barium chloride to reduce suspended solid concentrations and to co-precipitate radium (Ref. 6, p. 20-21). Effluent discharged to San Mateo Creek contained 300 to 600 mg/l TDS. Out of 9 trace elements for which treated minewaters were analyzed, molybdenum, selenium, and uranium concentrations were consistently higher than in natural runoff. Median total uranium concentration in mine effluents from the Ambrosia Lake mining district was 1.6 mg/l, which was over 16 times greater than the corresponding median concentration in natural runoff. Median total molybdenum concentration in minewater from the Ambrosia Lake mining district was 0.80 mg/l, which compares to the few samples of natural runoff in which total molybdenum concentration exceeded 0.01 mg/l. Total median selenium concentrations in treated minewater generally are less than 0.04 to 0.09 mg/l; however some treated effluents within the district approach 1.0 mg/l. Median total selenium concentration in natural runoff within the Ambrosia Lake mining district is 0.03 mg/l. Arsenic, vanadium, and barium, the latter of which is added in the treatment process, are occasionally detected in significant concentrations in minewaters; cadmium, lead, and zinc are usually below detectable concentrations (Ref. 6, p. 87). Median total barium concentration was 0.212 mg/l (Ref. 6, p. 88). Elevated concentrations of arsenic and vanadium in treated effluent (0.05 and 0.17 mg/l respectively) were only observed in association with the Homestake ion exchange facility, which was located within the Ambrosia Lake area (Ref. 6, p. 87, 97).

With the exception of natural uranium, total concentrations of radionuclides in treated minewaters are less than those in natural runoff. Most mines discharged minewaters with total concentrations of $radium_{226}$ of 6 picocuries per liter ("pCi/L") or less; about 30 percent of this may have been in the dissolved form. However, EID collected effluent samples with total $radium_{226}$ concentrations up to 200 pCi/L; these higher concentrations were attributed to the existence of "upset" conditions in the treatment process. Neither thorium isotopes nor $radium_{228}$ were generally present in detectable concentrations. Total $lead_{210}$ concentrations up to 33 pCi/L and total $polonium_{210}$ concentrations up to 15 pCi/L were detected from treated minewaters; higher concentrations—up to several hundred pCi/L—may have occurred during periods of ineffective minewater treatment (Ref. 6, p. 90).

Generally treated minewaters contained trace elements and radionuclides in dissolved form; typically, these dissolved contaminant concentrations comprised more than 50% of the total. More than 85% of the total concentration of gross alpha activity, molybdenum, selenium and natural uranium occurred in the dissolved fraction, while $radium_{226}$ concentrations averaged about 30% of the total (Ref. 6, p. 87). With the exception of natural uranium, radionuclide concentrations in minewaters in the dissolved phase were higher in comparison to concentrations in natural runoff (Ref. 6, p. 90). Dissolved gross alpha levels were several hundred to over 1,000 pCi/L in dewatering effluents (Ref. 6, p. 90). Only $radium_{226}$ and $lead_{210}$, among trace elements and radionuclides identified to have had elevated concentrations in effluent, underwent significant partitioning changes between dissolved and suspended phases with distance traveled; these constituents were usually became bound to precipitates and sediments and were lost from solution shortly after release. Once precipitated or bound to stream sediments, minewater contaminants could be moved downstream during natural or artificially-induced flow events. (Ref. 6, p. 90, 92). Within relatively sediment-free stream channels, these contaminants would stay in solution; dissolved $radium_{226}$ concentrations along the Arroyo del Puerto ranged between 3 and 6 pCi/L. Dissolved $radium_{226}$ concentrations also were attenuated by the alkaline and oxidizing conditions that are found in the GMB (Ref. 6, p. 109). Concentrations of uranium, molybdenum, and major dissolved solids generally were not rapidly attenuated in the receiving stream channels (Ref. 6, p. 92).

Mechanisms that were inferred to reduce contaminant concentrations most effectively in alluvial ground water impacted by minewater effluents include dilution, surface adsorption, cation exchange, precipitation, hydrodynamic dispersion, and molecular diffusion.

Sludges in treatment ponds that are created from settling, flocculation, and precipitation have elevated concentrations of $radium_{226}$ and other radionuclides, with concentrations of the former exceeding 200 pCi/gram (Ref. 6, p. 82). Separate ion-exchange treatment reduced elevated concentrations of dissolved uranium (Ref. 6, p. 20-21). Although treatment reduced concentrations of radium$_{226}$, lead$_{210}$, polonium$_{210}$, natural uranium, and gross alpha activity, other constituent concentrations were not affected (Ref. 6, p. 80).

3.2 Ground water pathway

The ground water pathway assesses the threat to human health and the environment by determining whether hazardous substances are likely to have been released to ground water; and whether any receptors are likely to be exposed to hazardous substances as a result of a release.

3.2.1 Hydrogeology

Alluvial aquifers along San Mateo Creek generally yield less than 50 gpm, where water occurs from a few feet to 100 feet below the surface (Ref. 6, p. 14). Available data indicate the presence of little alluvial ground water along the Arroyo del Puerto under pre-mining conditions (Ref. 6, p. 95). Near Ambrosia Lake, the Alluvial aquifer presently yields less than 150 gallons per day, and is expected to return to pre-mining/pre-milling conditions of little to no saturation (Ref. 32, p. 2). Alluvial ground water flows generally correspond to the slope of the land along San Mateo Creek (Ref. 6, p. 14). Depths to ground water in 1981 along San Mateo Creek were generally near 60 feet near its intersection with the tributary Arroyo del Puerto. Along the latter watercourse, 1981 depths to water were approximately 24 feet (Ref. 6, p. 16). Measurements conducted near the San Mateo Creek gaging station in 1980 showed little effect on alluvial ground water levels from intense summer thunderstorms, but did demonstrate a hydraulic response to late winter and spring stream flow (Ref. 6, p. 74).

Bedrock aquifers are recharged where streamflows or minewater discharge intersect bedrock subcrops and outcrops (Ref. 6, p. 13, 77). Additional bedrock aquifer recharge occurs where saturated valley fill overlie permeable bedrock with a downward hydraulic gradient (Ref. 6, p. 77). Mine dewatering has decreased aquifer water levels significantly, especially in the Morrison Formation (Ref. 6, p. 13). The Westwater Canyon member of the Morrison Formation is a principal bedrock aquifer in the area, yielding up to several hundred gpm (Ref. 6, p. 13). Mine dewatering drained virtually all of this formation and altered its flow system. Prior to dewatering, ground water generally flowed to the northeast and east in the direction of the dip of the strata (Ref. 42, p. 3). Other reliable aquifers include the Dakota Sandstone, the Glorieta Sandstone, and the San Andres Limestone.

3.2.2 Ground water use

Ground water uses in the area include domestic, limited agricultural, and livestock watering, with the latter primarily derived from alluvial wells (Ref. 6, p. 14). Within the boundaries of the proposed Site, drinking water systems for the community of San Mateo (Water system no. NM3525733; Ref. 20), Tri-State Generating Station (Water system no. NM3595017; Ref. 43), ARCO (Anaconda) Coal Company—Bluewater Mill (Water system no. NM3591033; Ref. 44), and

Homestake Mill (Water system no. NM3598133; Ref. 45) are listed with the NMED Drinking Water Bureau.

The water supply system for the community of San Mateo has 2 wells, of which only one is currently active. The system serves 192 people through 61 service connections (Ref. 20, p. 1). The supply wells of this system are completed in the Point Lookout Sandstone (Ref. 42, p. 2). NMED queried for non-coliform sample results available on-line; no occurrences of analyte concentrations that exceed Federal (Ref. 9; Ref. 10) or State (Ref. 11) drinking water standards were noted among the data available (Ref. 20).

The Tri-State Generating Station system is an industrial/agricultural system that serves a population of 125 from 10 wells and a reservoir; 2 of the wells are shown to be inactive (Ref. 43, p. 1). NMED queried for non-coliform sample results available on-line; one sample collected between 2004 and 2007 exceeded the MCL for gross beta particle activity (Ref. 9; Ref. 43, p. 2).

The Bluewater Mill system served a population of 60 from 5 service connections that were sourced from 4 wells. The wells are currently shown to be inactive, and no analytical data for this system were available on-line (Ref. 44).

The Homestake Mill system served a population of 24 through 17 connections, and was sourced by one well. This well currently is shown to be inactive, and no analytical data for this system were available on-line (Ref. 45).

Three wells and a spring within a 4-mile radius of the Navajo-Brown Vandever Mine (CERCLIS ID NND986669117; see Table 3) were noted during an inspection, with ground water levels in 1990 in 2 wells within 100 feet of an adit depth. At that time, these wells were a portion of the water supply to 430 people (Ref. 41).

Due to the complexity of the Site, ground water usage and potential impacts to wells located within Site target distance limits was not analyzed in accordance with Ref. 46, p. 61 (Ref. 47, p. 8). Figure 4 shows details of wells registered with the New Mexico Office of the State Engineer, and Table 5 summarizes well usage, within the San Mateo Creek basin.

Just outside of the Site boundaries, the communities of Grants (Water system no. NM3526133; Ref. 48) and Milan (Water system no. NM3525533; Ref. 49), and the Golden Acres Trailer Park (Water system no. NM3525133; Ref. 50) maintain regulated water supply systems. The Grants system serves a population of 8,892 through 3,211 service connections that are sourced from 3 wells, one of which is shown to be inactive (Ref. 48, p. 1). The wells are completed into basalt, alluvium, the San Andres Limestone, and the Glorieta Sandstone (Ref. 6, p. 14).

The Milan water system serves a population of 1,911 through 1,043 service connections that are sourced from 4 wells, one of which is shown to be inactive

(Ref. 49, p. 1); these wells are completed into the San Andres Limestone (Ref. 6, p. 14).

The Golden Acres Trailer Park system serves a population of 81 through 23 service connections that is sourced from 1 well, which currently is shown to be inactive (Ref. 50).

The Mount Taylor Millworks water system is an industrial/agricultural system that is sourced from one well. The system serves a population of 65. NMED queried for non-coliform sample results available on-line; no occurrences of analyte concentrations that exceed Federal (Ref. 9; Ref. 10) or State (Ref. 11) drinking water standards were noted among the data available (Ref. 51).

3.2.3 Ground water investigation

Ground water data from the period preceding mining inception were limited to single-event sampling of isolated windmills for general chemical characteristics, such as sulfate and TDS, and no trace element or radionuclide data are available in the San Mateo Creek (Ref. 6, p. 94) and the Arroyo del Puerto (Ref. 6, p. 95) drainages. Pre-mining alluvial ground water quality was assessed by data obtained from wells located upstream of uranium industry activities, including the Lee wells along San Mateo Creek. These data indicate that natural alluvial ground waters along San Mateo Creek trend from sodium bicarbonate water at the Lee Ranch to sodium-sulfate-bicarbonate water downstream at the Sandoval Ranch windmill. TDS concentrations increase from 540 to 650 mg/l within this 6-mile distance (Ref. 6, p. 95). Molybdenum concentrations in water from the Lee wells were consistently less than 0.010 mg/l (Ref. 6, p. 95). Uranium concentrations also were consistently less than 0.010 mg/l in these alluvial wells. At the Sandoval Ranch, pre-mining uranium concentrations were estimated to have been less than 0.030 mg/l. The EPA estimated that overall natural uranium concentrations within the Ambrosia Lake mining district approached 0.1 mg/l (Ref. 6, p. 100). Selenium concentrations were generally less than 0.005 mg/l in the Lee wells; at the downstream Sandoval Ranch windmill, EID measured a selenium concentration of 0.018 mg/l in 1980 sample, which is thought to represent an upper limit estimate of pre-mining ground water selenium concentration. Natural ground water selenium concentrations may increase downstream from the Sandoval Ranch due to contribution from selenium-enriched sediments in Poison Canyon (Ref. 6, p. 100-101).

Ground water monitoring was conducted by EID between 1977 and 1982 from stations established in San Mateo Creek and Arroyo del Puerco to characterize the quality of natural ground waters and the impacts of uranium mining to these waters—specifically to characterize hydraulic and contaminant migration relationships between surface water and shallow ground water using monitor well clusters (Ref. 6, p. 21, 26). Available data indicate the presence of little alluvial ground water along the Arroyo del Puerto under pre-mining conditions (Ref. 6, p. 95). Mine dewatering throughout the GMB transformed ephemeral streams into perennial streams, increasing recharge to underlying alluvial aquifers, which raised water levels and shallow well yields up to 50 feet between the onset of dewatering in the 1950s and the late 1970s (Ref. 6, p. 66, 77). In March and early April 1980, when mine dewatering discharge to San Mateo Creek was insignificant, occasional flows of less than 1 cubic foot per second (cfs) caused the alluvial water table to rise slowly. In contrast, streamflow increase to 3 cfs in late April, which lasted nearly two weeks, caused the water table to rise within one week, peaking in mid-May more than one foot higher than the level in mid-April (Ref. 6, p. 74). When minewater discharges were reduced, alluvial water levels monitored below the confluence of Arroyo del Puerto and San Mateo Creek declined eight feet between March 1978 and March 1982 (Ref. 6, p. 77).

Investigation of the impacts to ground water in the vicinity of the Section 35 and 36 mines indicate that alluvial ground water in this area was sourced principally from the dewatering activities (Ref. 33, p. 23).

At certain locations along San Mateo Creek, alluvial ground water chemistry more chemically resembled minewaters than natural waters. Minewater constituents that adsorb to sediments or that formed insoluble precipitates, such as radium$_{226}$, were not found in alluvial ground water in significant concentrations (Ref. 6, p. 94; Ref. 33, p. 23). Other constituents that either do not interact with stream sediments or that form insoluble precipitates, such as uranium, selenium, or molybdenum, were found in ground waters in concentrations approaching those in undiluted minewaters (Ref. 6, p. 94).

As previously noted, streamflows recharge bedrock aquifers at subcrop and outcrop areas, or where the saturated alluvium overlies permeable bedrock with downward hydraulic gradient (Section 3.2.1). At these localities, dewatering effluents also are introduced into these bedrock aquifers (Ref. 6, p. 77). Although minewater discharge to Arroyo del Puerto and San Mateo Creek are significant recharge sources to the Dakota and Morrison formations, local water level declines greater than 500 feet resulted from mine dewatering (Ref. 6, p. 77).

In general, test wells that have been affected by minewaters show concentrations of uranium, molybdenum, selenium, and gross alpha particle activity to be elevated above natural levels by 10 to 40 times (Ref. 6, p. 102). Chemical indicators in alluvial ground water to impacts from mine dewatering are inferred to include molybdenum concentrations greater than 0.03 mg/l, uranium concentrations greater than 0.03 mg/l upstream and 0.1 mg/l downstream of the confluence of San Mateo Creek with Arroyo del Puerto, selenium concentrations greater than 0.15 mg/l along San Mateo Creek upstream of the confluence, major changes in TDS concentrations and general chemistry with a distance of less than 3 miles, and significant declines in molybdenum, uranium, or selenium concentrations with increasing depth in the upper portion of the alluvial aquifer (Ref. 6, p.101). The presence of elevated selenium concentrations alone are not sufficient to demonstrate minewater effluent impacts (Ref. 6, p. 107).

Shallow ground water quality in the San Mateo Creek—Arroyo del Puerto drainage was transformed by dewatering effluents. One mile above the confluence of these watercourses, alluvial ground water at the Sandoval monitoring well cluster is indicative of sodium-sulfate-bicarbonate water chemistry, with a TDS concentration of about 650 mg/l. Downstream from the confluence, test wells produce ground water that ionically resembled Ambrosia Lake mining district minewaters (i.e., calcium-magnesium-sulfate type), with TDS over 2,100 mg/l (Ref. 6, p. 102). Mean uranium, molybdenum, and selenium concentrations at the Lee wells are below detectable concentrations of 0.005 to 0.01 mg/l; at the Sandoval well cluster, uranium and molybdenum concentrations are 10 to 20 times detectable limits, which was attributed to the effect of effluent infiltration. Below the confluence with the Arroyo del Puerto, uranium, molybdenum, and selenium concentrations were approximately 3 times higher than at the Sandoval well cluster. Uranium and molybdenum concentrations in the Otero wells are as much 7 times greater than projected natural levels in this portion of the San Mateo Creek drainage, indicating water quality degradation from minewater. Both uranium and molybdenum concentrations decrease with depth (Ref. 6, p. 105). Gross alpha particle activity also was significantly elevated along San Mateo Creek below the Lee wells, which reflects uranium concentrations almost exclusively (Ref. 6, p. 105).

Ground water restoration for the HMC site has been ongoing in 4 aquifers (i.e., Alluvial, Upper Chinle, Middle Chinle, and Lower Chinle) since 1977 (Ref. 12, p. 1.1-1). Monitoring data from 2006 indicates that concentrations of one or more site contaminants of concern exceed site ground water standards (Ref. 8), as well as Federal (Ref. 9 and 10) and State (Ref. 11) drinking water standards within each of the impacted aquifers (Ref. 12, p. 4.3-21, 4.3-39, 4.3-53, 4.3-73, 4.3-90, 4.3-107, 4.3-124, 4.3-141, 5.3-8, 5.3-12, 5.3-15, 5.3-18, 5.3-21, 5.3-24, 5.3-27, 6.3-8, 6.3-12, 6.3-15, 6.3-18, 6.3-21, 6.3-24, 6.3-27, 7.3-6, 7.3-10, 7.3-13, 7.3-16, 7.3-19). Several monitor wells within the underlying San Andres aquifer (Ref. 12, p. 8.0-4; Ref. 13), which is not addressed by the Homestake restoration (see Ref. 12, p. 1.1-1) have shown uranium concentrations exceeding Federal (Ref. 9) and State (Ref. 11) drinking water standards; most of these detections do not appear to be related to the HMC site (Ref. 14).

3.3 Soil exposure pathway

The soil exposure pathway assesses the threat to human health and the environment by direct contact with hazardous substances and areas of suspected contamination. This pathway addresses any material containing hazardous substances that is on or within 2 feet of the surface and not capped by an impermeable cover.

3.3.1 Soil exposure pathway description

An ongoing EPA risk assessment for the Homestake site will investigate the potential for contaminated soil source to impact human health through media including plant and animal uptake, as well as by direct contact (Ref. 52). The need to further characterize this pathway will be dependent upon waste characteristics at individual mine and mill sites within the Site.

3.3.2 Soil investigation results

Pond and stream sediment analytical and soils analytical data collected from the Poison Canyon Mining District are shown in Table 4. These data, in comparison to background samples collected within the same area, indicate elevated concentrations of $uranium_{238}$, $uranium_{234}$, $thorium_{230}$, $radium_{226}$, $lead_{210}$, vanadium, lead, and copper in one or more of these samples (Ref. 40). Selenium is locally enriched in soils and plants in the Poison Canyon area (cited in Ref. 6, p. 100).

The investigation of soil impacts from dewatering activities associated with the Section 35 and 36 mines indicate that radium$_{226}$ and uranium concentrations in soil, while decreasing with increasing depth, exceed assumed background concentrations. Exclusive of arsenic, total metals concentrations are below New Mexico Environment Department (NMED) Soil Screening Levels, and leachable metals concentrations, excluding selenium, and leachable major ions and TDS are below New Mexico Water Quality Control Commission (WQCC) standards (Ref. 33, p. 7-8).

3.4 Surface water pathway

The surface water pathway assesses the threat to human health and the environment by determining whether hazardous substances are likely to have been released to surface water; and whether any receptors (intakes supplying drinking water, fisheries, sensitive environments) are likely to be exposed to a hazardous substance as a result of a release.

3.4.1 Hydrology

Most streams are ephemeral within the GMB. Peak runoff from heavy late-summer thunderstorms and lesser flows from snow melt in late winter and early spring carry high sediment loads (Ref. 6, p. 13). San Mateo Creek has flowed continuously since construction of San Mateo Reservoir near the community of San Mateo; however this flow usually is ephemeral within 1 mile below San Mateo (Ref. 6, p. 13). Average stream bed loss along San Mateo Creek is approximately 0.72 cubic meters per minute per kilometer (Ref. 6, p. 72). Infiltration rate in the Ambrosia Lake mining district was calculated to be 7.54 cubic meters per minute (Ref. 6, p. 74).

3.4.2 Surface water use

Ephemeral perennial streamflows that were created from mine dewatering were important livestock water supplies (Ref. 6, p. 14). Surface water in the GMB, both from natural or mining-impacted sources, was used for livestock watering. Only artificially-maintained perennial streams were used for irrigation. No domestic use of surface water has been documented (Ref. 6, p. 111).

3.4.3 Surface water investigation

Natural runoff has average suspended sediment concentrations greater than 30,000 mg/l. Flow within San Mateo Creek typically has suspended sediment concentrations less than 400 mg/l. TDS concentrations in flow within Arroyo del Puerto that was influenced by mine discharge were 1,500 to 2,000 mg/l; occasionally natural waters diluted these concentrations to less than 1,000 mg/l (Ref. 6, p. 84).

In natural runoff, contaminants are generally associated with suspended sediment and precipitates (Ref. 6, p. 87). Natural runoff has median concentrations of total molybdenum and selenium of less than 0.01 and 0.03 mg/l respectively (Ref. 6, p. 87). Median total barium concentrations in natural runoff is 7.7 mg/l (Ref. 6, p. 88). As much of 99% of the gross alpha and gross beta particle activities in natural runoff are associated with precipitates and suspended sediment. Dissolved gross alpha levels are generally less than 20 picocuries per liter ("pCi/L"), with dissolved uranium accounting for more than 80 percent. Total $radium_{226}$ concentration in natural runoff often exceeds 15 pCi/L, but usually has less than 2 pCi/L of dissolved $radium_{226}$. Natural runoff typically has concentrations of total $lead_{210}$ and $polonium_{210}$ between 40 and 90 pCi/L respectively (Ref. 6, p. 90).

Surface water monitoring was conducted by EID between 1977 and 1982 from stations established in San Mateo Creek and Arroyo del Puerto to characterize the quality of natural surface waters and the impacts of uranium mining to these waters—specifically to characterize hydraulic and contaminant migration relationships between surface water and shallow ground water. Monitoring locations included flow from both uranium mine dewatering effluents and natural perennial flow (Ref. 6, p. 21). Additionally, single-stage samplers were installed within ephemeral watercourses above and below mine waste piles to characterize runoff; additionally grab samples collected during runoff events above and below waste piles (Ref. 6, p. 32).

EID investigators concluded that TDS concentrations in perennial stream flows throughout the GMB varied between less than 200 to greater than 1,500 mg/l, with the lowest TDS values found in the perennial flow of San Mateo Creek (Ref. 6, p. 43-44). Dissolved trace element and radionuclide concentrations in both perennial and ephemeral flows throughout the GMB are very low, due to the low solubility of these materials and the prevailing neutral to slightly alkaline nature of the flows (Ref. 6, p. 45). Suspended sediment concentration in the San Mateo perennial flow had a log mean concentration of 10 mg/l, while ephemeral flow in the same streamcourse had a log mean concentration of 8,100 mg/l (Ref. 6, p. 47). Total trace element and radionuclide concentrations in natural runoff generally were dependent upon sample sediment amounts. Molybdenum was virtually absent from runoff (Ref. 6, p. 48). In turbid waters, gross alpha particle activity among 5 samples ranged from 33 pCi/L to 2,100 pCi/L, with a median concentration of 1,200 pCi/L. Gross beta particle activity among 4 samples ranged from 546 pCi/L to 2,000 pCi/L, with a median concentration of 1,060 pCi/L (Ref. 6, p. 48). The majority of $radium_{226}$ and $lead_{210}$ concentrations found in turbid water samples were bound to sediments (Ref. 6, p. 51). Maximum gross alpha particle activity exceeded maximum natural runoff activity by 200 times. Maximum levels of natural uranium and $radium_{226}$, which are 2 major alpha particle emitters, exceed natural maximum runoff levels by over 100 times. Gross beta particle activity, especially from $lead_{210}$, also far exceed natural runoff levels (Ref. 6, p. 57).

As noted previously (Section 3.1), runoff sampling below uranium mine waste piles indicated that sediment concentrations were comparable to natural sediment concentrations.

3.5 Air pathway

The air pathway assesses the threat to human health and the environment by determining whether hazardous substances are likely to have been released to the air; and whether any receptors (human population and sensitive environments) are likely to be exposed to hazardous substances as a result of a release. The need to characterize this pathway will be dependent upon waste characteristics at, and population densities near, individual mine and mill sites within the Site.

4.0 Summary and conclusions

NMED has identified 85 formerly-producing uranium minesites and 4 uranium millsites (Ref. 7) within the approximately 321 square mile (Ref. 3) San Mateo Creek basin (Ref. 3, 4) for investigation of potential sources of background ground water contaminant concentrations that exceed Federal (Ref. 9 and 10) and State (Ref. 11) drinking water standards. Population density within the area of the Site is between 6 (Ref. 19, p. 2) and 13 people (Ref. 19, p. 1) people per square mile. The communities of Grants and Milan, which are located just outside of the boundaries of the Site, have populations of 8,806 (Ref. 21) and 1,891 (Ref. 22) people respectively. Therefore, the total potentially-impacted population within a 4-mile radius of the Site boundaries is inferred to be between 10,000 and 30,000 people.

Analyses of waste rock samples from the Poison Canyon Mining District showed that contaminant concentrations are elevated relative to background (Ref. 40). EID analyzed composite minewaste samples from within the Site to determine contaminant leachability (Ref. 6, p. 34-35); these tests indicated that these materials had relatively low potential for leaching and ground water degradation (Ref. 6, p. 57). Nevertheless, the EID investigation also noted that the contaminant concentrations in runoff from mine waste exceeded natural concentrations (Ref. 6, p. 54, 55, 57).

Water produced from mine dewatering contained elevated contaminant concentrations (Ref. 6, p. 80, 84), and produced perennial flows in San Mateo Creek and Arroyo del Puerto (Ref. 6, p. 66, 68, 72, 77). These flows increased recharge to alluvial aquifers in the Ambrosia Lake mining district. Mine discharge elevated TDS concentrations in Arroyo del Puerto surface water flows (Ref. 6, p. 84). Maximum levels of natural uranium and $radium_{226}$, as well as gross alpha and beta particle activity, exceeded natural runoff levels within the GMB (Ref. 6, p. 57). Although the effluents were treated to reduce solids and radium concentrations (Ref. 6, p. 20-21), some contaminant concentrations were found to be higher than was found in natural runoff (Ref. 6, p. 87, 88, 90). EID collected effluent samples with elevated concentrations of $radium_{266}$, $lead_{210}$, and $polonium_{210}$ that were attributed to episodes of ineffective minewater treatment (Ref. 6, p. 90). Some contaminants were observed to precipitate or bind to stream sediments where available, but would move downstream during flow events; in relatively sediment-free stream channels, contaminant concentrations were not readily attenuated (Ref. 6, p. 90, 92).

Little data are available to determine ground water quality before the inception of mining (Ref. 6, p. 94-95). Mine dewatering increased recharge to, and water levels in, alluvial aquifers (Ref. 6, p. 21, 26, 66, 74, 77; Ref. 33, p. 23). Mine dewatering changed hydrologic conditions throughout the Site (Ref. 6, p. 13; Ref. 42, p. 3). Alluvial ground water was found to have some geochemical similarities to minewaters (Ref. 6, p. 94, 101, 102, 105, 107); natural attenuation was found to moderate some geochemical effects (Ref. 6, p. 94; Ref. 33, p. 23).

Bedrock ground water levels were greatly reduced from the dewatering activities (Ref. 6, p. 13; Ref. 42, p. 3). However, where bedrock aquifers subcrop alluvial aquifers or outcrop in streamcourses, the dewatering effluents recharged these aquifers (Ref. 6, p. 77).

Within the Site boundary, ground water supplies water systems for the community of San Mateo (Ref. 20), and the Tri-State Generating Station (Ref. 43). The community of Haystack also uses ground water (Ref. 41). Immediately outside of the Site boundary are water systems for the communities of Grants (Ref. 48) and Milan (Ref. 49), as well as the Golden Acres Trailer Park (Ref. 50). Another water system in the area is registered to the Mount Taylor Millworks (Ref. 51). Available ground water usage is summarized in Table 5.

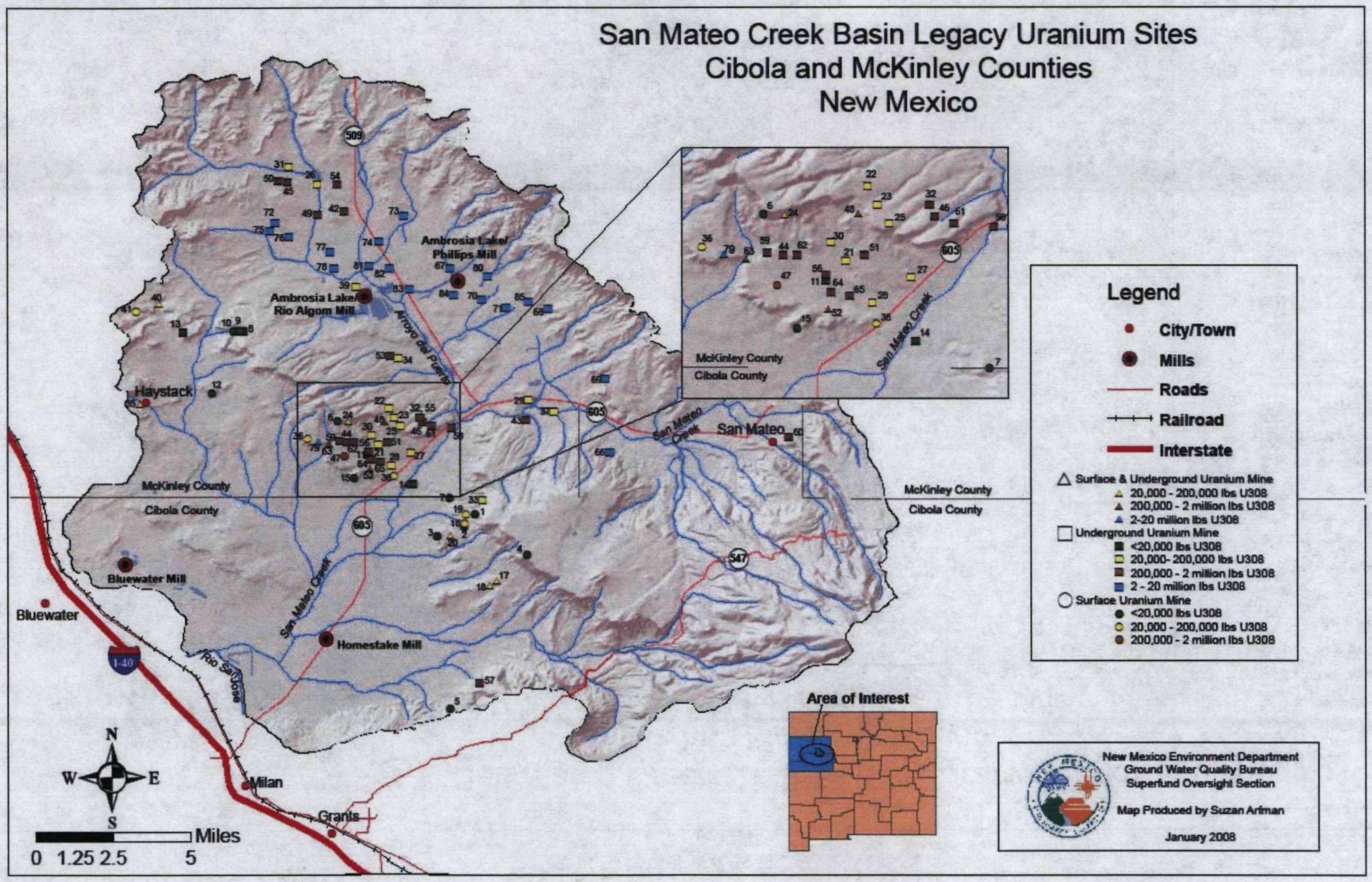
Sludges produced in ponds, in which mine effluents were treated, had some elevated contaminant concentrations (Ref. 6, p. 20-21, 80, 82).

Soil samples from the Poison Canyon Mining District show elevated contaminant concentrations (Ref. 40), as do samples taken from soils impacted by Section 35 and 36 mine dewatering (Ref. 33, p. 7-8). Soil samples from areas impacted by dewatering of the Section 35 and 36 mines indicate radium$_{226}$ and uranium concentrations in soil exceed assumed background concentrations. Exclusive of arsenic, total metals concentrations are below New Mexico Environment Department (NMED) Soil Screening Levels, and leachable metals concentrations, excluding selenium, and leachable major ions and TDS are below New Mexico Water Quality Control Commission (WQCC) standards (Ref. 33, p. 7-8).

The air pathway was not evaluated for this study, but should be studied during recommended further CERCLA investigation of this Site.

5.0 Figures

Figure 1: Mines and mill locations
Ref. 3, 4, 5, 7, 53, 54



Notes:
Symbology for mines is derived from Ref. 7 according to the following schema:

- Surface and underground, underground, and surface uranium mine categorization (Ref. 55).
- Production categorization (Ref. 56).

See Table 1 for mine information.

Figure 2: Bedrock geology of the San Mateo Creek drainage
References as for Figure 1 plus Ref. 57

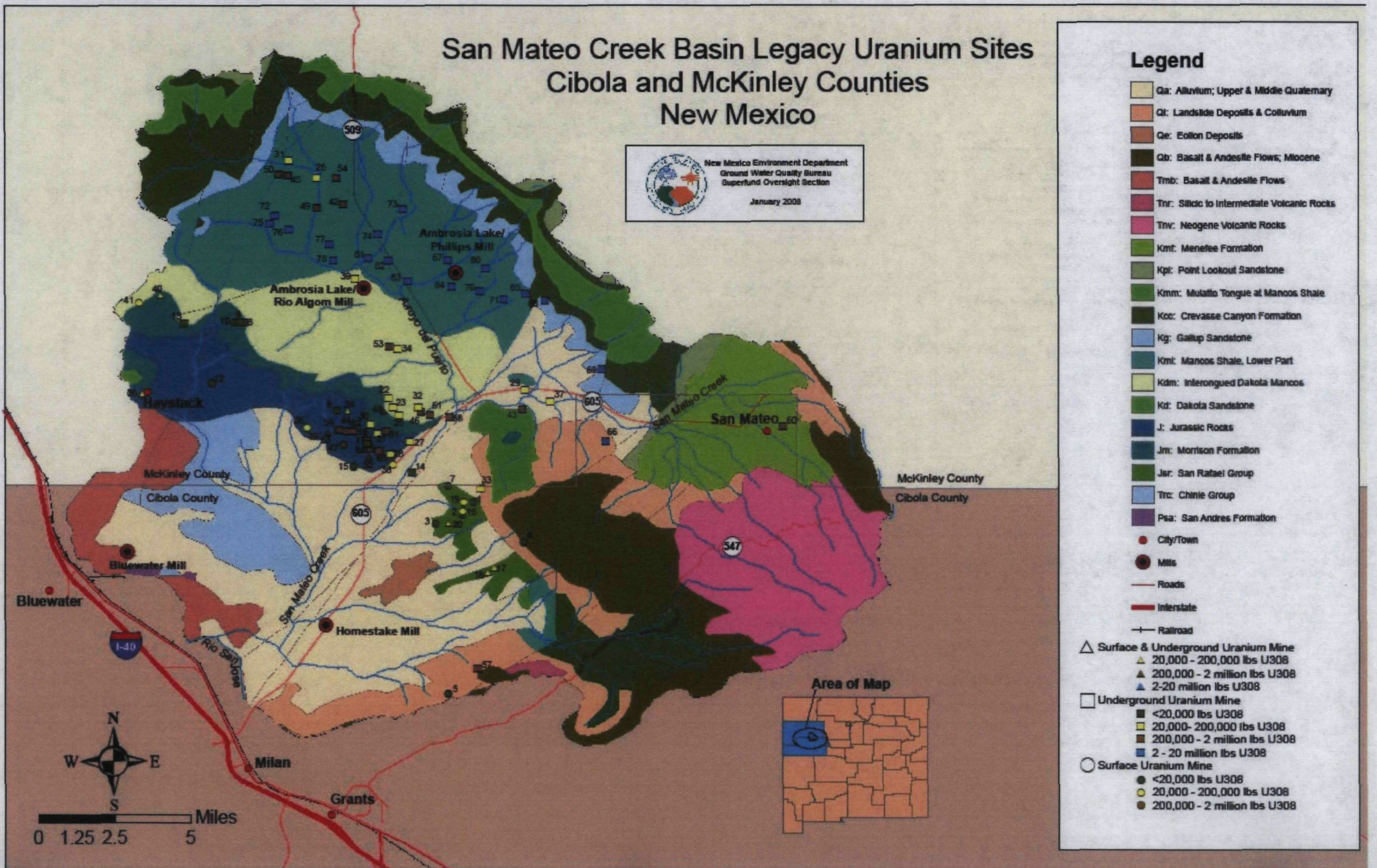


Figure 3: Surficial landownership within the San Mateo Creek drainage basin
References as for Figure 1 plus Ref. 29

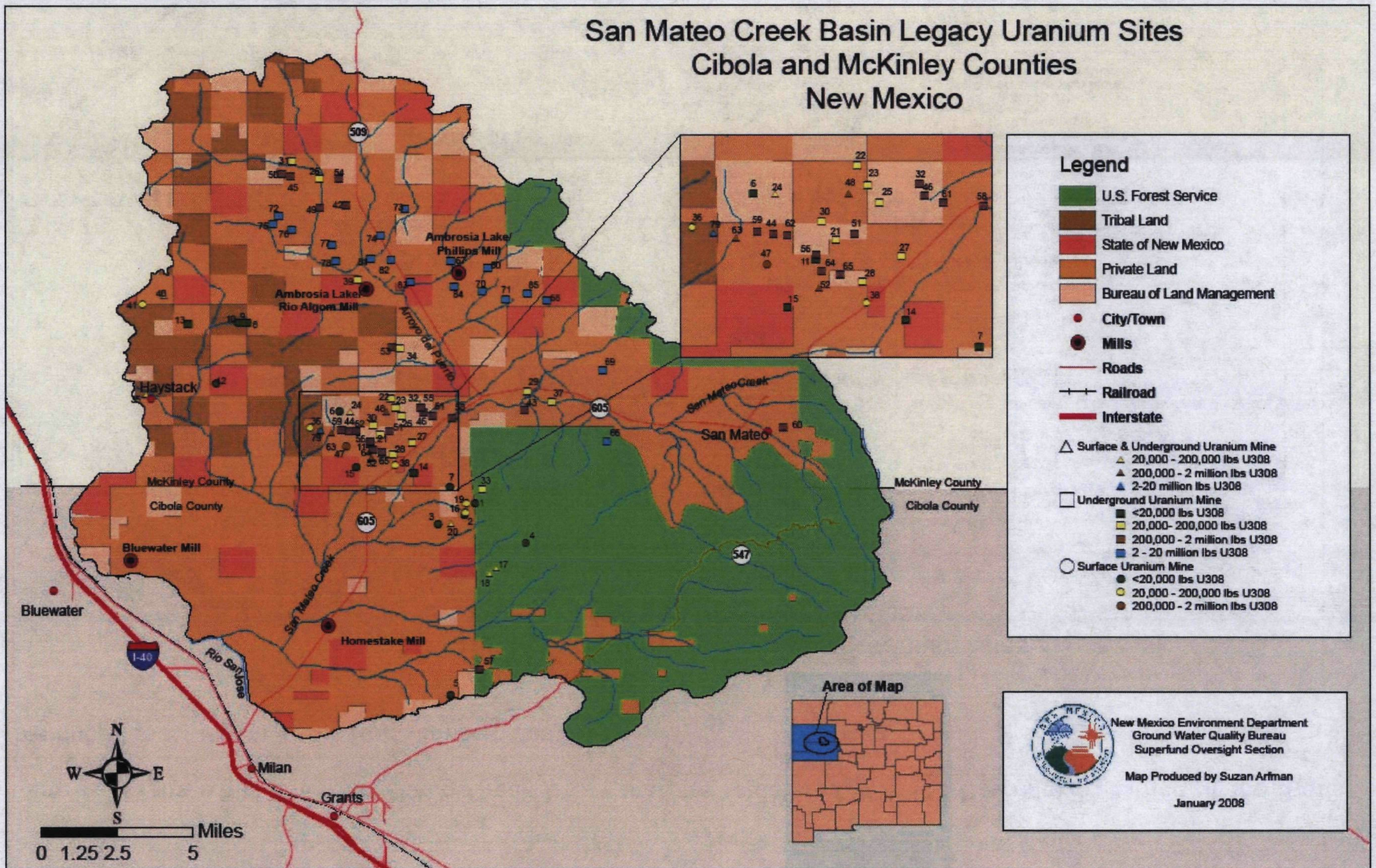
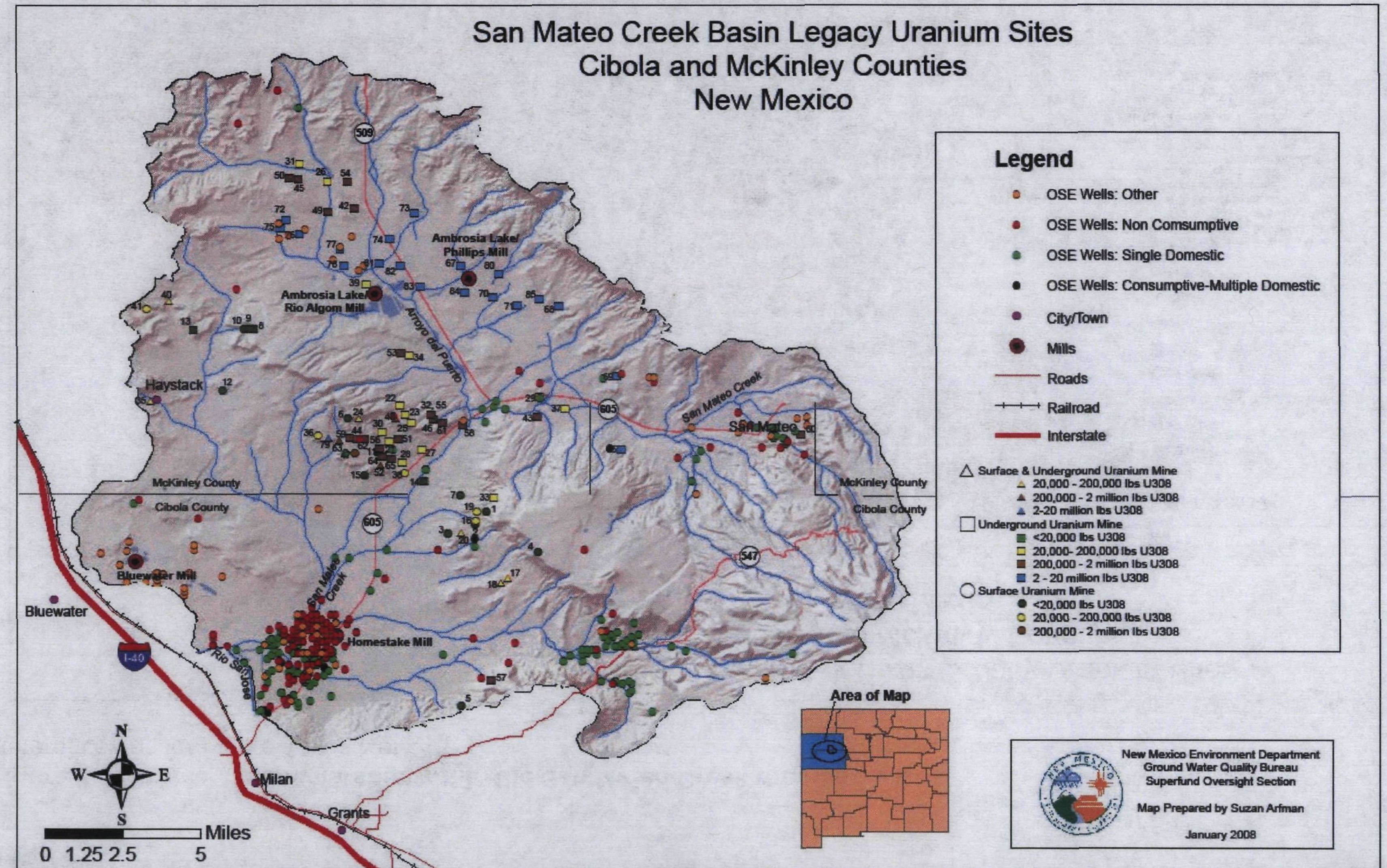


Figure 4: Wells within the San Mateo Creek basin that are registered with the New Mexico Office of the State Engineer
References as for Figure 1 plus Ref. 58 (see notes)



Notes to Figure 4:
Wells data from Ref. 58, and are summarized by use categories (Ref. 59, 60) in this figure as follows:

- OSE wells: Other = includes DEW, EXP, MIN, MON, NOT, OBS, PRO, and PUB categories and entries with no category (i.e., blanks)
- OSE wells: Non consumptive = includes IND, IRR, SAN, STK categories
- OSE wells: Single domestic = includes DOM category
- OSE wells: Consumptive—multiple domestic = includes MUL, MOB, MDW categories

Table 1: Mines within the Site boundary
All data excerpted from Ref. 7

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
1	Christmas Day	Phil, Christmas Day No. 1-4		Bureau of Land Management	surface	1954	1956	a		dump 700 cps; workings 500-700 cps	
2	Gay Eagle				surface	1952	1965	a			
3	Last Chance	Bottoms		Bureau of Land Management	surface	1951	1956	a			
4	Taffy	Bonanza No. 1, Trustco Corp	U. S. Forest Service	U. S. Forest Service	surface	1961	1961	a		background 50 cps; high 4,500 cps	
5	Tom	Tom No. 13, Tom Group, Vanadium	private or Bureau of Land Management	private or Bureau of Land Management	surface	1954	1955	a			
6	Bobcat		Bureau of Land Management	Bureau of Land Management	surface	1956	1956	a	4.80	debris	
7	Charlotte	Section 33, Farris	Sonny & Isabel Marquez	Newmont Mining Co.	surface	1958	1958	a		background 50 cps; face cut 125 cps	
8	Pat	Dakota Mine, Gossett, Black Rock, Section 4, Martinez Lease	Navajo Allotee	Navajo Allotee	underground	1952	1963	a	5.59	background 90-130 cps; adits 3,900 cps; stope 3,500 cps	
9	Dakota		Navajo Allotee	Navajo Allotee	underground	1952	1963	a-f	2.36	background 50 cps; high 500 cps	
10	Junior	Pat, Section 4	Navajo Allotee	Navajo Allotee	surface	1953	1953	a-f	7.64	background 70 cps; max 200 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
11	Piedra Trieste	Section 30, Piedra Lisa	Bureau of Land Management	Bureau of Land Management	underground	1979	1981	a	15.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; adit timbering removed, incline pit backfilled with mine waste, 2 air shafts backfilled with gravel
12	Red Point	R. M. Shaw	State Land Office	State Land Office	surface	1952	1955	a	1.83	background 50 cps; pits 3,800 cps; dumps 1,500 cps	
13	Section 5	Westvaco, Febo, Los Tres Mosquetero s	Cerrillos Land Company	Newmont Mining Co.	underground	1958	1958	a	2.89	background 50 cps; adit 800 cps	
14	Moe No. 4	Section 32	State Land Office	State Land Office	underground	1961	1963	a		background 20-30 cps, dump high 2,200 cps	
15	Red Bluff No. 1	Rimrock, Homer Scriven, Section 36	State Land Office	State Land Office	surface	1952	1964	a	7.51	pit 1,100 cps	
16	Black Hawk, Bunney, Red Bluff	Section 4, Bunney Group	Bureau of Land Management, private	Bureau of Land Management	surface	1952	1967	b			
17	La Jara	Zia, La Jara No. 1-9	U. S. Forest Service	U. S. Forest Service	surface, underground	1952	1960	b	4.00	background 70 cps; open pit 150-200 cps	
18	Zia		U. S. Forest Service	U. S. Forest Service	underground, surface	1952	1958	b-f	4.00	background 70 cps; adit (S) 1,700 cps; waste pile 600 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
19	Red Bluff No. 1, 2, 3, 4, 5,	Elkins and Jones			surface	1952	1976	b		max 1,000 cps	
20	Section 9	Mark Elkins, Anaconda			surface, underground	1950	1962	b		adit 10,000 cps	
21	Barbara J No. 1	Whitecap, Dalco, Barbara Jean No. 1	Bureau of Land Management	Bureau of Land Management	room and pillar	1956	1968	b	7.00		1993 Mar/Apr: Contractor: Khani Co., headframe demolished, shaft plugged with 3 ft bentonite plug and backfilled with waste from Barbara J No. 3 site; 1980: Anderson observed shaft backfilled & site regraded
22	Beacon Hill Gossett	Malpais No. 10 & 14; Section 18, Moe No. 3	Bureau of Land Management	Bureau of Land Management	underground, open stope	1956	1978	b	15.00		1993 Mar/Apr: Contractor: Khani Co.; loading structure & powder magazine demolished, decline adits plugged with mine waste, 2 ventilation shafts backfilled, diversion ditches constructed on uphill slopes
23	Beacon Hill	Mesa Top, Malpais, East Malpais, Davenport, Beacon Hill No. 18-23	Bureau of Land Management	Bureau of Land Management	underground	1956	1967	b-f			1993 Mar/Apr: Contractor: Khani Co.; shaft backfilled

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
24	Blue Peak	Garcia No. 1-5, Red Top No. 1-10, Section 24	Bureau of Land Management	Bureau of Land Management	underground, stripping	1951	1965	b	6.34		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; timber loadout dismantled, backfilled 5 adits with on-site mine waste
25	Davenport	Moe No. 2, Davenport Incline	Bureau of Land Management		underground	1957	1966	b	6.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; powder box dismantled, decline and adit backfilled with mine waste from Davenport and Mesa Top Mines
26	Dysart No. 2	Section 11, SE Shaft	? Homestake Mining Co.	? Homestake Mining Co.	underground	1959	1983	b		background 75 cps; main dump intersecting road 1,500 cps; small dump 1,100 cps	
27	Faith	Section 29, Westvaco	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1958	1964	b	1.00		1986 shafts backfilled, surfaces recountoured, reseeded
28	F[illegible]p	Fife and Bailey, Vilatie Hyde	Bureau of Land Management	Bureau of Land Management	undergroun[illegible]	[illegible]5	1966	b	10.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; timber/debris removed from adit, chute removed, 5 subsidence areas backfilled with mine waste & graded, adit backfilled with mine waste, 3 vent holes back[illegible]d with gra[illegible]

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
29	Hogan	Lucky Dooley, Fence, Plain		Bureau of Land Management	underground	1959	1962	b		background 50cps; shaft 450cps; dump 200-400 cps	shaft cross-timbered and 10-15 ft concrete plug poured
30	Hope	Section 19	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1977	1981	b	10.00		1991/2 Cerrillos Land Co. regraded waste rock, shaft backfilled, revegetated
31	Mary No. 1	Section 11 NWQ, Dysart No. 3	??? Homestake Mining CO.	??? Homestake Mining Co.	underground	1959	1965	b	33.88	shaft 400-600 cps high 1,200 cps; dump 600-1,500 cps	
32	Mesa Top	Mesa Top No. 5, Malpais, Davenport, Malpais No. 13, Beacon Hill No. 18-20	Bureau of Land Management	Bureau of Land Management	underground, open stope	1954	1958	b	10.00		
33	Vallejo	Double Jerry, Section 34, Farris No. 1	U. S. Forest Service	U. S. Forest Service	underground	1957	1963	b	2.00	portal 350-600 cps	
34	Spencer	Section 8, Centennial, State No. 1-27 claims	Bureau of Land Management	Bureau of Land Management	underground	1958	1980	b		background 70cps; dump area 300-600 cps	1997 Nov: AML installed 350 ft fencing
35	Section 18	Williams and Thompson, Brown Vandever, Federal Mine	Navajo Allotee	Navajo Allotee	underground, surface	1952	1966	b	12.68	stockpile 1,000 cps; stope 150 cps	
36	Haystack Section 23	Sec 23 & 26 Open Pit	Navajo Tribal Fee (Sec 23), Navajo Allotee (Sec 26)	Navajo Tribal Fee (Sec 23), Navajo Allotee (Sec 26)	surface	1957	1966	b	17.61	face cuts 1,500 cps; mineralized zones 5,000 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
37	Chill Willis	Rialto, Section 13, Section 24	Marquez Ranch	Conoco	underground	1960	1963	b		background 50 cps; dump 600 cps with 1,500 cps1500 cps, stock pile 600-1,000 cps	
38	Haystack Section 31	Santa Fe Railroad, Henri Dole, Section 31 NWQ	Isabella O. Marquez Trust	Newmont Mining Corp.	surface	1953	1975	b		background 20-30 cps, dump 150 cps	1987 pits backfilled; 1994 fall Santa Fe Pacific Gold reclaimed & reseeded, debris removed; 1995 trespass dumping & minor erosion observed
39	United Western	J and M, Section 36, Lease 60-167, VCA mine	State Land Office	State Land Office	underground	1957	1960	b		dump 700-900 cps	1980 Anderson: shaft backfilled, buildings removed; equipment salvaged; Per AML 1989 in Grants Phase 1 recon: no threat, reclaimed
40	Febco	Silver Spur No. 1-5, Berryhill-Elkins, Small Stake	Berryhill Family	Berryhill Family	surface, underground	1952	1966	b	4.16	portals 350 cps; tailings dumps 800-1,200 cps	
41	Silver Spur	Febco, Silver Spur No. 5	Berryhill Family	Berryhill Family	surface	1955	1958	b-f	3.31	pits 1,800-2,000 cps; dump 900 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
42	Section 13	Westwater Corp.	Jerry & Luann Elkins	Newmont Mining Corp.	underground	1979	1981	c	20.00		1991 Aug buildings removed and buried on site; boreholes backfilled and sealed with reinforced concrete cap; shaft backfilled and capped with reinforced concrete cap; 1992 May-June earthwork to reconfigure/cover waste piles; placement of topsoil; 1992 Ju
43	Marquez	Marcus, Calumet	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1958	1971	c		dump 800-2,500 cps; stockpile 10,000 cps; high readings on streambed road	1987 Santa Fe Pacific Gold declined adit shaft backfilled; structures removes; regraded; 12in topsoil depth - all sand
44	Divide	Section 25	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	underground	1952	1973	c-f	0.58	background 20-30 cps; outcrop 300-350cps	
45	Dysart No. 1	Rio de Oro, Section 11	unknown	unknown	underground	1956	1983	c	58.55	background 70 cps; shaft 700-1,000 cps, dump/stockpile 400-700 cps	
46	Dog	Dog Incline, Flea Incline; Dog-Flea, B-G Group, BG Group, Section 20	Bureau of Land Management	Bureau of Land Management	underground	1957	1975	c	30.00	dumps 350-750 cps; waste washing into arroyo	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
47	Section 25 SEQ	Desiderio, Amiran, Operation Haystack, Rimrock No. 1	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	surface	1952	1981	c	63.56	background 20-30 cps; waste 900 cps; pits 2,000-3,300 cps	
48	Poison Canyon	Moe No. 1	Isabella O. Marquez Trust	Newmont Mining Corp.	surface, underground	1952	1978	c	30.00		1987 shafts backfilled; 1993 & 1994 additional reclamation activities; 2000 erosional rilling reclaimed
49	Bucky	Section 14, Jeep No. 1-6, Buckey, Buckly	Cobb Resources	Bureau of Land Management	underground	1957	1982	c	27.43		
50	Section 10	Kermac, Regomex, Ambromex, Buffalo	Cobb Resources, ??? Bureau of Land Management	Cobb Resources, ??? Bureau of Land Management	underground	1957	1981	c	16.48	shaft 400 cps with high 900cps; dump 400-700 cps; ventilation shaft air >6,000 cps	by 1980 shaft secured with wire mesh fence
51	Barbara J No. 3	Fife and Bailey, Barbara Jean No. 3	Bureau of Land Management	Bureau of Land Management	underground	1959	1980	c	5.00		1980 shaft covered by Todilto; 1993 Mar/Apr: Contractor: Khani Co.; casing, water tank, timbering, etc. removed, 1 shafts closed with 2-ft bentonite plug and backfilled with riprap, 1 ventilation shaft backfilled with riprap, vent holes backfilled

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
52	Roundy - Manol	Manol, F. Manol, Roundy Lease, Rimrock No. 3, Section 30			surface, underground	1952	1981	c	6.30	background 20-30 cps, dumps 500-600 cps with 1,000-2,200 cps high	
53	Isabella	Section 7	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1959	1980	c	2.00	background 80 cops; shaft area outside fence 350 cps; waste dumps 1,000-1,7000 cps with 2,000 spikes; high readin	
54	Section 12	Dysart Group, Tana and Alto	Bureau of Land Management	Cobb Resources	underground	1961	1982	c			
55	Malpais	Malpais No. 13, Dog No. 10, East Malpais, Malpais raise, Mesa Top	Bureau of Land Management	Bureau of Land Management	underground	1958	1961	c	8.00		1993 Mar/Apr: Contractor: Khani Co.; casing, water tank, timbering, etc. removed, 1 shafts closed with 2-ft bentonite plug and backfilled with riprap, 1 ventilation shaft backfilled with riprap, vent holes backfilled
56	Barbara J No. 2	Whitecap, Dalco No. 1, Barbara Jean No. 2	Bureau of Land Management	Bureau of Land Management	underground	1957	1968	c	8.00		1993 Mar/Apr: Contractor: Khani Co.; headframe removed, shaft backfilled with mine waste (shaft collapsed during construction)

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
57	F-33	Section 33, Anaconda, Forest Group, Head & Keely	Atlantic Richfield Co.	Atlantic Richfield Co.	underground	1954	1977	c	39.00		1970s surface buildings removed; 6/17/1994 reclamation completed; reclamation included permanent closure of portals Nos. 1, 2, 4, 5 and vent raise (portal No. 3 never developed), mine waste backfilled into tunnels and portals; slopes 3h:1v or less, 12 in
58	Doris	Section 21, Doris No. 1, Little Doris, Doris decline, Flea-Doris extension,	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1958	1981	c	10.00		1991/1992 Cerrillos Land Co. both declines sealed, erosion control features, debris removed, revegetated, waste rock regraded
59	Section 25 shaft		Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	underground	1963	1967	c-f	18.58	background 20-30 cps; dumps 3200 cps	
60	Mount Taylor	Gulf, Chevron	Rio Grande Resources, Inc.	Rio Grande Resources, Inc.	underground	1980	1990	c	66.00		
61	Flea	Flea-Doris Extension	Bureau of Land Management (Sec 20), State Land Office (Sec 16), private (Sec	Bureau of Land Management (Sec 20), State Land Office (Sec 16), private (Sec	underground	1957	1980	c-f	20.00		1993 Mar/Apr: Contractor: Khani Co., 2 adits reclaimed: removed wire mesh and tin cloures, removed timbering, backfilled with mine waste, 30-mil PBC cover installed on opening, 12" topsoil, diversion ditches constructed on uphill slopes

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
62	Section 25 Decline	Tag claims, Red Rock	Elkins Real Estate, Berryhill Ranch, Ltd. (Sec 25), Bureau of Land Managemet	Newmont Mining Corp. (Sec 25), Bureau of Land Managemetn (Sec 24)	underground	0	0	c-f	2.89	background 20-30 cps; max 400cps	
63	Section 25 Open Pit	Desiderio, Amiran	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	underground, surface	1952	1981	c-f	21.69	background 20-30 cps; waste 900 cps; pits 2,000-3,300 cps	1980s: Amiran/Reserve backfilled features after lease expired; 1993 Santa Fe Pacific reclaimed & reseeded; 1994: additional reclamation; debris removed; rainwater impoundment for livestock; 12" soil depth
64	Roundy Strip	Rimrock No. 1, Manol, Section 30, H-H-50, Mano No. 1, Golden P. Roundy			underground	1952	1971	c-f		pits 300-600 cps	
65	T-20	T-9 orebody, Rimrock No. 2, T-20 shaft, Q-32	Bureau of Land Management	Bureau of Land Management	underground	1955	1968	c-f	5.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; shaft collar and grating removed, 2 subsidence areas backfilled with mine waste, 5 vent holes backfilled with gravel, shaft backfilled with waste material, 1 ft topsoil, seeded

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
66	San Mateo	Section 30, Rare Metals	U. S. Forest Service	U. S. Forest Service	underground	1959	1971	d		surface & groundwater contamination ; waste dumps 8-25uR/hr; settling basins 100-450 uR/hr	1980s Homestake backfilled main shaft with mine water materials
67	Ann Lee	Phillips No. 1, Section 28, Spider Rock	United Nuclear Corp.	Hecla Mining	underground	1958	1982	d	0.10		portion of mine included in Phillips UMTRA Title I Site; 1994 shaft backfilled with mill/mine waste & capped with 4ft thick, 20 sq ft concrete slab; barbed wire fence; 3-ft topsoil cover, seeded
68	Cliffside	Section 36, Section 1	State Land Office (Sec 36), Isabella O. Marquez Trust (Sec 1)	State Land Office (Sec 36), Hecla Mining & Newmont Mining Corp. (Sec 1)	underground	1960	1988	d			1990 Quivira reclaimed per SLO specs ; 3-cased vent holes remain on site as monitoring wells
69	Johnny M	Ranchers	John E. Motica, Fernandez Co.	Newmont Mining Corp.	underground	1976	1982	d			1982: mined-out areas backfilled with tailings, shaft sealed with concrete plug, portal sealed with concrete plug; 1993: Fed Reg Docket No. 40-8914 released 5/13/1993
70	John Bully	John Bully shaft, Sandstone	United Nuclear Corp	Hecla Mining	underground	1959	1980	d-f			

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
71	Sandstone	Section 34, John Billy shaft	United Nuclear Corp	Hecla Mining	underground	1959	1980	d	8.00		1980s: headframe removed; 1994 fall: barbed-wire fence; shafts backfilled and topped with concrete cap; 2ft soil depth; seeded
72	Section 15	Homestake Sapin Mine No. 15	Jerry & Luann Elkins	Newmont Mining Corp.	underground	1958	1981	d	30.00		1991 Aug-Sept: buildings demolished & buried on site, shaft & decline backfilled & capped with reinforced concrete; boreholes backfilled & capped; ponds/containment berms flattened; 1992 May-June: *earthwork to* reconfigure/cover waste piles; placement of
73	Section 17	Jerry Wayne No.. 1-36, Carter, Section 18, Shale No. 1-36	Rio Algom (Sec 17,18), Bureau of Land Management (Sec 20)	Rio Algom (Sec 17,18), Bureau of Land Management (Sec 20)	underground	1960	2002	d	22.00		1994 June Quivira reclaimed
74	Section 19	Section 20	Rio Algom (Sec 19), Bureau of Land Management (Sec 20)	Rio Algom (Sec 19), Bureau of Land Management (Sec 20)	underground	1962	2002	d	19.00		1994 June Quivira reclaimed
75	Section 22		Rio Algom	Rio Algom	underground	1958	2002	d	37.00		1994 June Quivira reclaimed

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
76	Section 23		Rio Algom	Newmont Mining Corp.	underground	1959	1989	d	100.00		1991 August: buildings, headframe, hoist equipment, IX plant & trash removed, building material buried on site, IX plant disposed at Grants mill site, shaft backfilled & sealed with reinforced concrete shaft, boreholes backfilled and capped with concrete
77	Section 24	Section 24 and 26, Mine No. 24	Rio Algom (Sec 24), Bureau of Land Management (Sec 26)	Rio Algom (Sec 24), Bureau of Land Management (Sec 26)	underground	1959	2002	d	26.00		1994 June Quivira reclaimed
78	Section 25	Homestake Sapin No. 25	Homestake Mining Co., Elbert Roundy Ranch	Newmont Mining Corp.	underground	1958	1990	d	115.00		1991 August: buildings, headframe, hoist equipment, IX plant & trash removed; building material buried on site, IX plant disposed at Grants mill site, shaft backfilled & sealed with reinforced concrete, boreholes backfilled & capped with concrete, inject
79	Section 26	Hanosh, Indian Allotment, Desidero	Navajo Allotee	Navajo Allotee	surface, underground	1952	1980	d	15.24	open pit 1,800 cps	
80	Section 27	United Nuclear	Schmitt Ranches	Hecla Mining	underground	1967	1981	d	15.00		

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
81	Section 30 West		Rio Algom	Rio Algom	underground	1970	2002	d	26.00		1994 June Quivira reclaimed
82	Section 30	Carter 1-36, Section 29, Mining Unit 30	Rio Algom	Rio Algom	underground	1958	2002	d	44.00		1994 June Quivira reclaimed
83	Section 32	United Western, UP-HP, Section 29, Section 31	State Land Office (Sec 32), private	State Land Office (Sec 32), private	underground	1958	1982	d	60.00		1991 Aug-Sept: buildings removed & buried on site, boreholes backfilled & sealed with reinforced concrete, shaft backfilled & capped with reinforced concrete, containment berms dozed into ponds, earthwork to reconfigure/cover waste piles, placement of to
84	Section 33	Mining Unit 33, Branson, Section 29	Rio Algom	Rio Algom	underground	1959	2002	d	28.00		1994 June Quivira reclaimed
85	Section 35	Elizabeth, Section 36	Rio Algom	Rio Algom	underground	1971	2002	d	40.00		

Summary of mines by mine working mode and production categories
Ref. 61

Mine workings mode category	Production category	Number of mines
Surface	<20,000 lbs U_3O_8	10
	20,000—200,000 lbs U_3O_8	5
	200,000—2 million lbs U_3O_8	1
Surface and underground	20,000—200,000 lbs U_3O_8	6
	200,000—2 million lbs U_3O_8	3
	2 million – 20 million lbs U_3O_8	1
Underground	<20,000 lbs U_3O_8	5
	20,000 – 200,000 lbs U_3O_8	15
	200,000—2 million lbs U_3O_8	20
	2 million – 20,000 million lbs U_3O_8	19
TOTAL		**85**

__Notes:__
Fig_index no. = reference number that has been assigned to mines on figures within this document

MINE NAME = "popular name"
ALIASES = alternate mine names
SURFACE OWNERSHIP = Surface ownership
MINERAL OWNERSHIP = Mineral ownership
MINING_MET = surface, underground, or in-situ leach [see Figure 1]
1st YEAR = Year of first uranium production
LAST YEAR = Year of final uranium production (does not indicate continuous production)
PRODUCTION = NMBGMR production categories [see Figure 1].

e	> 20 million lbs U3O8
d	2 - 20 million lbs U3O8
c	200,000 – 2 million lbs U3O8
b	20,000 – 200,000 lbs U3O8
a	< 20,000 lbs U3O8
f	included with another mine
u	production unknown

DISTURBED = Extent of disturbance in acres
RADIATION = any known radiological measurements at the site
RECLAMATION = reclamation details, including dates, actions/abatement completed

Table 2: ACLs for the Anaconda Bluewater Uranium Mill in comparison to ground water regulation standards

Alluvial aquifer

Contaminant	ACL (mg/l; Ref. 35, p. 4)	Maximum Contaminant Limit (MCL; [page number in Ref. 9])	New Mexico Water Quality Commission (NMWQCC) standards (mg/l ([page number in Ref. 11])
Molybdenum	0.10	NA	1.0 [13]
Uranium	0.44 (300 pCi/L)	0.30* [431]	0.30 [12]
Selenium	0.05	0.05 [428]	0.05 [12]

San Andres aquifer

Contaminant	ACL (mg/l; Ref. 35, p. 4)	Maximum Contaminant Limit (MCL; [page number in Ref. 9])	New Mexico Water Quality Commission (NMWQCC) standards (mg/l ([page number in Ref. 11])
Selenium	0.05	0.05 [428]	0.05 [12]
Uranium	2.15	0.30 [431]	0.30 [12]

*converted from micrograms per liter (µg/l; Ref. 62)

Table 3: CERCLIS status of individual sites within the Site boundary
Ref. 36

Site name	CERCLIS ID	Reference page	Actions	Date completed	Reference page
Brown Vandever Mine	NND986669117	1	Discovery Preliminary Assessment Archive site Site inspection	03/01/1990 07/17/1990 12/10/1992 12/10/1992	2
Anaconda Co Bluewater Uranium Mill	NMD007106891	3	Discovery Archive site Preliminary Assessment	04/01/1980 04/01/1980 04/01/1980	4
Haystack Butte Mining District	NMD980878771	5	Discovery Preliminary Assessment Archive site Site inspection	09/01/1984 11/01/1984 12/01/1985 12/01/1985	6
Kerr-McGee Nuclear Corp	NMD005570015	7	Discovery Archive site Preliminary Assessment	02/01/1980 02/01/1981 02/01/1981	8
Mt. Taylor Uranium Mine	NMD000778605	9	Preliminary Assessment Discovery Site inspection Archive Site	04/01/1981 05/01/1981 04/01/1986 09/26/1994	10
Poison Canyon Mining District	NMD981600489	11	Discovery Preliminary Assessment Archive site Site inspection	12/01/1986 08/01/1987 10/01/1989 10/01/1989	12
UNC San Mateo Mine	NM1223075515	13	Discovery Preliminary Assessment Archive Site Site inspection	06/30/1988 01/20/1989 12/07/1995 12/07/1995	14
Febco Uranium Mine	NND986669166	15	Discovery Preliminary Assessment	07/16/1991 06/11/2001	16

Site name	CERCLIS ID	Reference page	Actions	Date completed	Reference page
Homestake Mining Company	NMD007860935	17	NPL listing	09/08/1983	18
			ROD	09/27/1989	18
			Five year review	09/27/2001	17
			Five year review	09/26/2006	17

Table 4: Analytical data from the Poison Canyon Mining District
Ref. 40, p. 2

Location	U_{238}	U_{234}	Th_{232}	Th_{230}	Ra_{226}	Pb_{210}	Vanadium	Lead	Copper
	pCi/g						µg/g		
Background									
A	5.53	6.80	0.50	6.86	6.30	6.60	6	<5	5
B	4.24	4.43	0.81	4.88	4.50	2.20	6	7	8
BJ #3A	1.29	1.22	0.40	3.23	3.92	2.00	12	6	9
Stream/pond sediments									
BJ Stream A	4.64	4.92	1.07	5.95	9.30	5.50	15	9	9
"Stock pond"	61.50	65.50	1.75	34.50	38.20	33.60	88	63	11
Waste rock/soils									
BJ #1	890.00	910		1150	1060	860	830	74	9
BJ #3B	140	142		175	72	93	66	5	<5
BJ #3C	5840	5730		5990	5600	4320	260	310	<5

Notes:
U_{238} = uranium 238
U_{234} = uranium 234
Th_{232} = thorium 232
Th_{230} = thorium 230
Ra_{226} = radium 226
Pb_{210} = lead 210
pCi/g = picocuries per gram
µg/g = micrograms per gram

Table 5: Ground water usage from wells within the Site boundary
Ref. 58

GROUND WATER USAGE			TOTALS
Consumptive			213
	Single domestic wells	203	
	Multiple domestic and community wells	10	
Irrigation, sanitary, industrial, and stock wells			241
Other well usages (including dewatering, exploration, mining, milling, oil, monitoring, no recorded use of right, observation, prospecting, construction, and no documented usage category)			79

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REFERENCE 1-4

Vol. 55 No. 241 Friday, December 14, 1990 p 51532 (Rule)
1/13065

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 300

[FRL-3730-8]

RIN 2050 AB73

Hazard Ranking System

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is adopting revisions to the Hazard Ranking System (HRS), the principal mechanism for placing sites on the National Priorities List (NPL). The revisions change the way EPA evaluates potential threats to human health and the environment from hazardous waste sites and make the HRS more accurate in assessing relative potential risk. These revisions comply with other statutory requirements in the Superfund Amendments and Reauthorization Act of 1986 (SARA).

DATES: Effective date March 14, 1991. As discussed in Section III H of this preamble, comments are invited on the addition of specific benchmarks in the air and soil exposure pathways until January 14, 1991.

ADDRESSES: Documents related to this rulemaking are available at and comments on the specific benchmarks in the air and soil exposure pathways may be mailed to the CERCLA Docket Office, OS-245, U.S. Environmental Protection Agency, Waterside Mall, 401 M Street, SW, Washington, DC 20460, phone 202-382-3046. Please send four copies of comments. The docket is available for viewing by appointment only from 9:00 am to 4:00 pm, Monday through Friday, excluding Federal holidays. The docket number is 105NCP-HRS.

FOR FURTHER INFORMATION CONTACT: Steve Caldwell or Agnes Ortiz, Hazardous Site Evaluation Division, Office of Emergency and Remedial Response, OS-230, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460, or the Superfund Hotline at 800-424-9346 (in the Washington, DC area, 202-382-3000).

SUPPLEMENTARY INFORMATION:

Table of Contents

Superfund Chemical Data Matrix (SCDM)

The Superfund Chemical Data Matrix (SCDM) is a source for factor values and benchmark values applied when evaluating potential National Priorities List (NPL) sites using the Hazard Ranking System (HRS). Factor values are part of the HRS mathematical equation for determining the relative threat posed by a hazardous waste site and reflect hazardous substance characteristics, such as toxicity and persistence in the environment, substance mobility, and potential for bioaccumulation. Benchmarks are environment- or health-based substance concentration limits developed by or used in other EPA regulatory programs. SCDM contains HRS factor values and benchmark values for hazardous substances that are frequently found at sites evaluated using the HRS, as well as the physical, chemical, and radiological data used to calculate those values. The accompanying SCDM Methodology report describes how data are selected or calculated for inclusion in SCDM and how SCDM data, HRS factor values, and benchmarks are presented in formatted printouts.

On January 28, 2004, EPA released an updated SCDM with many revisions to the HRS factor values and benchmarks. These revisions were necessary both because of updates in the SCDM procedures used to assign HRS factor values and benchmarks and because of revisions to pertinent standards and criteria for individual hazardous substances and their associated characteristics.

Superfund Chemical Data Matrix Report

- SCDM Methodology Report PDF
  - Part 1 - Table of Contents and Introduction (PDF) (5 pp, 283.3K)
  - Part 2 - Data Selection Methodology (PDF) (22 pp, 1.9MB)
  - Part 3 - Calculations in SCDM (PDF) (28 pp, 1.19MB)
- Appendix A - Chemical Data, Factor Values, and Benchmarks for Chemical Substances PDF
  - Part 1 - Acenaphthene to Cesium (PDF) (70 pp, 1.62MB)
  - Part 2 - Cesium 137(+D) (radionuclide) to Dichloropropane, 1,2 (PDF) (70 pp, 1.66MB)
  - Part 3 - Dichloropropene, 1,3- to Hexachlorodibenzofuran 1,2,3,7,8,9 (PDF) (70 pp, 1.65MB)
  - Part 4 - Hexachlorodibenzofuran 2,3,4,6,7,8- to Plutonium 236 (radionuclide) (PDF) (70 pp, 1.57MB)
  - Part 5 - Plutonium 238 (radionuclide) to Thorium 231 (radionuclide) (PDF) (70 pp, 1.60MB)
  - Part 6 - Thorium 232 (radionuclide) to Zinc 65 (radionuclide) and Footnotes (PDF) (61 pp, 1.43MB)
- Appendix BI - Hazardous Substance Factor Values (PDF) (15 pp, 155.8K)

- Appendix BII - Hazardous Substance Benchmarks (PDF) (32 pp, 413.5K)
- Appendix C - Hazardous Substance Synonyms Report (PDF) (3 pp, 72.8K)
- SCDM Interim Revised Values for Ammonia; Atrazine; Dibutyltin; Furfural; Nitrobenzene; Nitrosodimethylamine, N-; Perchlorate; Tributyltin; Tributyltin Oxide; and Trichloroethylene (TCE)
    - Ammonia Appendix A (PDF) (7 pp, 190.69K)
    - Ammonia Appendices BI & BII (PDF) (6 pp, 135.42K)
    - Atrazine Appendix A (PDF) (5 pp, 143.3K)
    - Atrazine Appendices BI & BII (PDF) (7 pp, 125.6K)
    - Dibutyltin Appendix A (PDF) (7 pp, 190K)
    - Dibutyltin Appendices BI & BII (PDF) (6 pp, 125.52K)
    - Furfural Appendix A (PDF) (5 pp, 201.2K)
    - Furfural Appendices BI & BII (PDF) (1 pg, 64.8K)
    - Nitrobenzene Appendix A (PDF) (5 pp, 205.2K)
    - Nitrobenzene Appendices BI & BII (PDF) (1 pg, 50.7K)
    - Nitrosodimethylamine, N- Appendix A (PDF) (5 pp, 207.1K)
    - Nitrosodimethylamine, N- Appendices BI & BII (PDF) (6 pp, 137.7K)
    - Perchlorate Appendix A (PDF) (5 pp, 66.8K)
    - Perchlorate Appendices BI & BII (PDF) (7 pp, 59K)
    - Tributyltin Appendix A (PDF) (7 pp, 180.49K)
    - Tributyltin Appendices BI & BII (PDF) (6 pp, 127.49K)
    - Tributyltin Oxide Appendix A (PDF) (7 pp, 197.17K)
    - Tributyltin Oxide Appendices BI & BII (PDF) (6 pp, 129.29K)
    - Trichloroethylene (TCE) Appendix A (PDF) (7 pp, 182.75K)
    - Trichloroethylene (TCE) Appendices BI & BII (PDF) (1 pg, 36.62K)

Please note that the January 2004 SCDM was developed by compiling a list of CERCLA hazardous substances used in the scoring of NPL sites since 1990. The previous SCDM versions were developed using all substances ever scored at a site using the original HRS. The January 2004 SCDM *does not include* any substance that has not been used in the scoring of a site since 1990, even if previously listed in SCDM.

There are 17 new entries (PDF) (1 pg, 41.3K) (with new CAS Numbers) in the January 2004 version of SCDM that were not in the 1996 version. There are 235 fewer entries (PDF) (5 pp, 57.6K). Some of these changes resulted from new naming conventions and more specific identification of isomers and congeners. Also, some substances were removed because they were pollutants and contaminants and not CERCLA hazardous substances.

NOTE: Please do not assume that any substance not listed in the January 2004 SCDM cannot be used for HRS scoring. The number of entries was reduced to save resources in developing, updating, and tracking changes in chemical properties. If values are needed for a substance that was not listed in the January 2004 SCDM and are thought to be critical to the listing decision, please request the value by calling the SCDM Helpline. As a preliminary value (for screening purposes only), the former 1996 value associated with the substance can be used, and EPA will verify the new value if necessary. For all technical questions concerning SCDM, please contact the SCDM Helpline.

For further technical SCDM information, contact:
SCDM Helpline
Available weekdays, 9:00 - 5:00 EST
Phone: (703) 461-2019
Email: SCDM@csc.com

For other SCDM information, contact:
Ms. Yolanda Singer
US Environmental Protection Agency

SUPERFUND CHEMICAL DATA MATRIX METHODOLOGY

Prepared For EPA
January 2004

National Hydrography Dataset (NHD) - High-resolution

Metadata also available as

Metadata:

- Identification_Information
- Data_Quality_Information
- Spatial_Data_Organization_Information
- Spatial_Reference_Information
- Entity_and_Attribute_Information
- Distribution_Information
- Metadata_Reference_Information

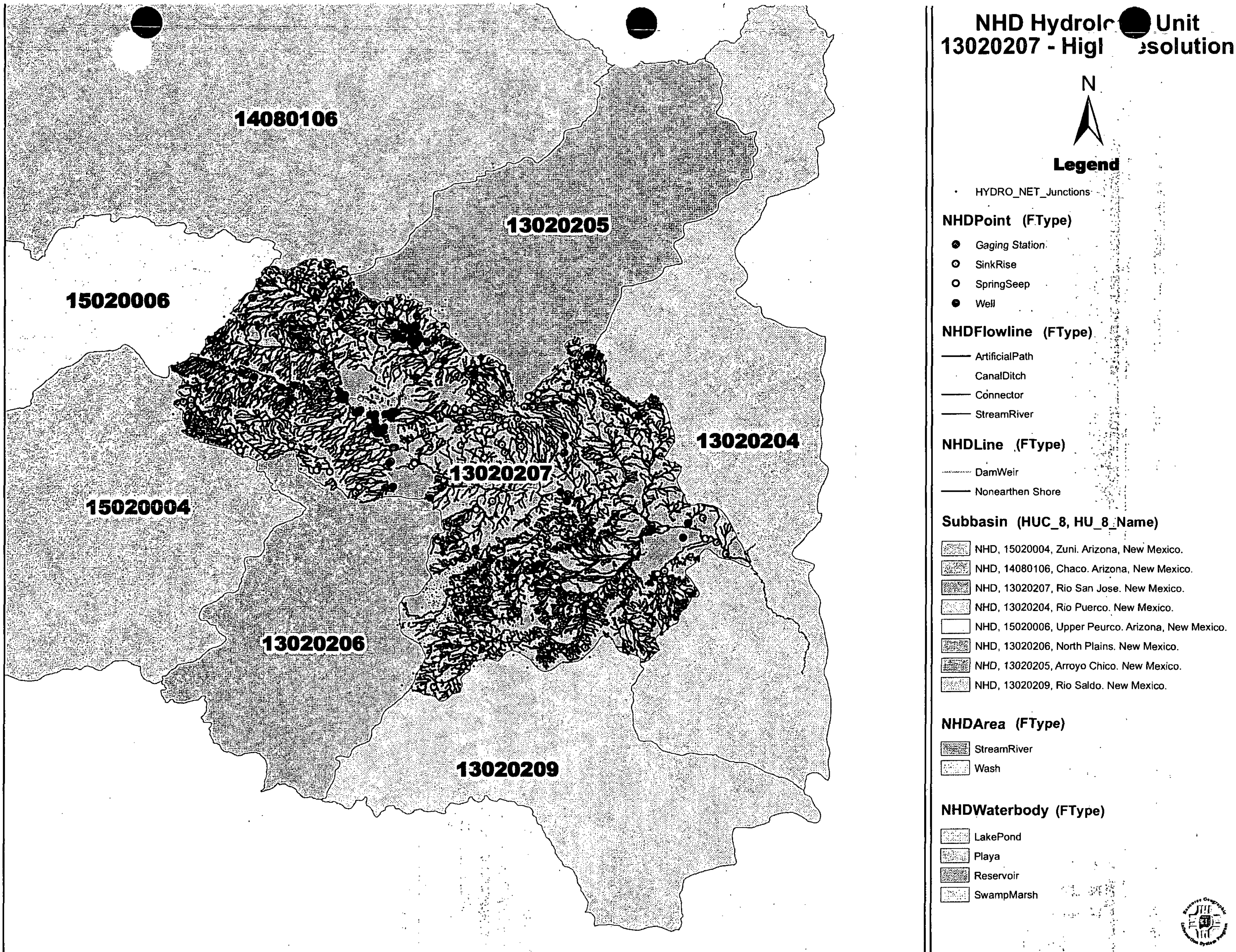
Identification_Information:
    Citation:
        Citation_Information:
            Originator:
                U.S. Geological Survey in cooperation with U.S. Environmental Protection Agency, USDA Forest Service, and other Federal, State and local partners (see dataset specific metadata under Data_Set_Credit for details).
            Publication_Date: See dataset specific metadata.
            Publication_Time: Unknown
            Title: National Hydrography Dataset (NHD) - High-resolution
            Geospatial_Data_Presentation_Form: vector digital data
            Publication_Information:
                Publication_Place: Reston, Virginia
                Publisher: U.S. Geological Survey
            Online_Linkage: <http://nhd.usgs.gov>
    Description:
        Abstract:
            The National Hydrography Dataset (NHD) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. This high-resolution NHD, generally developed at 1:24,000/1:12,000 scale, adds detail to the original 1:100,000-scale NHD. (Data for Alaska, Puerto Rico and the Virgin Islands was developed at high-resolution, not 1:100,000 scale.) Local resolution NHD is being developed where partners and data exist. The NHD contains reach codes for networked features, flow direction, names, and centerline representations for areal water bodies. Reaches are also defined on waterbodies and the approximate shorelines of the Great Lakes, the Atlantic and Pacific Oceans and the Gulf of Mexico. The NHD also incorporates the National Spatial Data Infrastructure framework criteria established by the Federal Geographic Data Committee.
        Purpose:

based on accuracy statements made for U.S. Geological Survey topographic quadrangle maps. These maps were compiled to meet National Map Accuracy Standards. For vertical accuracy, this standard is met if at least 90 percent of well-defined points tested are within one-half contour interval of the correct value. Elevations of water surface printed on the published map meet this standard; the contour intervals of the maps vary. These elevations were transcribed into the digital data; the accuracy of this transcription was checked by visual comparison between the data and the map. This statement is generally true for the most common sources of NHD data. Other sources and methods may have been used to create or update NHD data. In some cases, additional information may be found in the NHDMetadata table.

Lineage:
Process_Step:
Process_Description:
The processes used to create and maintain high-resolution NHD data can be found in the table called "NHDMetadata". Because NHD data can be downloaded using several user-defined areas, the process descriptions can vary for each download. The NHDMetadata table contains a list of all the process descriptions that apply to a particular download. These process descriptions are linked using the DuuID to the NHDFeatureToMetadata table which contains the com_ids of all the features within the download. In addition, another table, the NHDSourceCitation, can also be linked through the DuuID to determine the sources used to create or update NHD data.
Process_Date: Unknown
Process_Step:
Process_Description: See dataset specific metadata.

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector
Point_and_Vector_Object_Information:

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Geographic:
Latitude_Resolution: 0.000001
Longitude_Resolution: 0.000001
Geographic_Coordinate_Units: Decimal degrees
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222
Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: National Geodetic Vertical Datum of 1929
Altitude_Resolution: 0.1
Altitude_Distance_Units: meters


NHD Hydrolc Unit
13020207 - Higl esolution
N
Legend
HYDRO_NET_Junctions
NHDPoint (FType)
Gaging Station
SinkRise
SpringSeep
Well
NHDFlowline (FType)
ArtificialPath
CanalDitch
Connector
StreamRiver
NHDLine (FType)
DamWeir
Nonearthen Shore
Subbasin (HUC_8, HU_8_Name)
NHD, 15020004, Zuni. Arizona, New Mexico.
NHD, 14080106, Chaco. Arizona, New Mexico.
NHD, 13020207, Rio San Jose. New Mexico.
NHD, 13020204, Rio Puerco. New Mexico.
NHD, 15020006, Upper Peurco. Arizona, New Mexico.
NHD, 13020206, North Plains. New Mexico.
NHD, 13020205, Arroyo Chico. New Mexico.
NHD, 13020209, Rio Saldo. New Mexico.
NHDArea (FType)
StreamRiver
Wash
NHDWaterbody (FType)
LakePond
Playa
Reservoir
SwampMarsh
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13020205
15020006
13020204
13020207
15020004
13020206
13020209

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  Citation:
    Citation_Information:
      Originator: USDA/NRCS - National Cartography & Geospatial Center
      Title: Enhanced Digital Raster Graphic 30x60 1:100,000
  Description:
    Purpose: The Enhanced DRG is useful as a source or background layer in a GIS, as
a means to perform quality assurance on other digital products, and as a source for
the collection and revision of vector data.  The removal of the collar information
allows the Enhanced DRGs to be edge-matched and displayed simultaneously in a
Geographic Information System.
  Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 1963 - 1997
  Status:
    Progress: Planned
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -109.05017
      East_Bounding_Coordinate: -103.00196
      North_Bounding_Coordinate: 37.00029
      South_Bounding_Coordinate: 31.33217
  Keywords:
    Theme:
      Theme_Keyword_Thesaurus: Standard for Geospatial Dataset File Naming
      Theme_Keyword: Digital Raster Graphic, DRG
    Place:
      Place_Keyword_Thesaurus: GNIS
      Place_Keyword: New Mexico
      Place_Keyword: *
  Use_Constraints:

    The U.S. Department of Agriculture, Service Center Agencies should be
acknowledged as the data source in products derived from these data.

    This data set is not designed for use as a primary regulatory tool in permitting
or citing decisions, but may be used as a reference source.  This is public
information and may be interpreted by organizations, agencies, units of government,
or others based on needs; however, they are responsible for the appropriate
application.  Federal, State, or local regulatory bodies are not to reassign to the
Service Center Agencies any authority for the decisions that they make.  The Service
Center Agencies will not perform any evaluations of these data for purposes related
solely to State or local regulatory programs.

    Photographic or digital enlargement of these data to scales greater than at
which they were originally mapped can cause misinterpretation of the data.  Digital
data files are periodically updated, and users are responsible for obtaining the
latest version of the data.
  Point_of_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: National Cartography and Geospatial Center
      Contact_Address:
        Address: 501 W. Felix St, Bldg 23
        City: Fort Worth
        State_or_Province: Texas
        Postal_Code: 76115
Data_Quality_Information:
  Lineage:
    Source_Information:
      Source_Citation:
        Citation_Information:
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Metadata_Date: 2004-09-29
Metadata_Standard_Name: SCI Minimum Compliance Metadata
Metadata_Standard_Version: SCI Std 003-02

REFERENCES

5-8

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Identification_Information:
  Citation:
    Citation_Information:
      Originator:
        U.S. Department of Commerce
        Bureau of the Census
        Geography Division
      Publication_Date: 2001
      Title: TIGER/Line Files, Redistricting Census 2000
      Edition: Redistricting Census 2000
      Series_Information:
        Series_Name: TIGER/Line Files
        Issue_Identification: Version (MMYY) represents the month and year file
created
      Publication_Information:
        Publication_Place: Washington, DC
        Publisher:
          U.S. Department of Commerce
          Bureau of the Census
          Geography Division
  Description:
    Abstract:
      TIGER, TIGER/Line, and Census TIGER are registered trademarks of the Bureau
      of the Census. The Redistricting Census 2000 TIGER/Line files are an extract
      of selected geographic and cartographic information from the Census TIGER
      data base.  The geographic coverage for a single TIGER/Line file is a county
      or statistical equivalent entity, with the coverage area based on January 1,
      2000 legal boundaries.  A complete set of Redistricting Census 2000 TIGER/Line
      files includes all counties and statistically equivalent entities in the
United
      States and Puerto Rico.  The Redistricting Census 2000 TIGER/Line files will
      not include files for the Island Areas. The Census TIGER data base represents
      a seamless national file with no overlaps or gaps between parts.  However,
each
      county-based TIGER/Line file is designed to stand alone as an independent data
      set or the files can be combined to cover the whole Nation.  The Redistricting
      Census 2000 TIGER/Line files consist of line segments representing physical
      features and governmental and statistical boundaries.  The Redistricting
Census
      2000 TIGER/Line files do NOT contain the ZIP Code Tabulation Areas (ZCTAs) and
      the address ranges are of approximately the same vintage as those appearing in
      the 1999 TIGER/Line files.  That is, the Census Bureau is producing the
      Redistricting Census 2000 TIGER/Line files in advance of the computer
processing
      that will ensure that the address ranges in the TIGER/Line files agree with
the
      final Master Address File (MAF) used for tabulating Census 2000.  The files
contain
      information distributed over a series of record types for the spatial objects
of a
      county.  There are 17 record types, including the basic data record, the shape
      coordinate points, and geographic codes that can be used with appropriate
software
      to prepare maps.  Other geographic information contained in the files includes
      attributes such as feature identifiers/census feature class codes (CFCC) used
to
      differentiate feature types, address ranges and ZIP Codes, codes for legal and
      statistical entities, latitude/longitude coordinates of linear and point
features,
      landmark point features, area landmarks, key geographic features, and area
      boundaries.  The Redistricting Census 2000 TIGER/Line data dictionary contains
      a complete list of all the fields in the 17 record types.
    Purpose:
```

In order for others to use the information in the Census TIGER data base in a geographic information system (GIS) or for other geographic applications, the Census Bureau releases to the public extracts of the data base in the form of TIGER/Line files. Various versions of the TIGER/Line files have been released; previous versions include the 1990 Census TIGER/Line files, the 1992 TIGER/Line files, the 1994 TIGER/Line files, the 1995 TIGER/Line files, the 1997 TIGER/Line files, the 1998 TIGER/Line files, and the 1999 TIGER/Line files. The Redistricting Census 2000 TIGER/Line files were originally produced to support the Census 2000 Redistricting Data Program.

Supplemental_Information:
To find out more about TIGER/Line files and other Census TIGER data base derived data sets visit http://www.census.gov/geo/www/tiger.

Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2000
Currentness_Reference: 2000
Status:
Progress: Complete
Maintenance_and_Update_Frequency:
TIGER/Line files are extracted from the Census TIGER data base when needed for geographic programs required to support the census and survey programs of the Census Bureau. No changes or updates will be made to the Redistricting Census 2000 TIGER/Line files. Future releases of TIGER/Line files will reflect updates made to the Census TIGER data base and will be released under a version numbering system based on the month and year the data is extracted.

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: +131.000000
East_Bounding_Coordinate: -64.000000
North_Bounding_Coordinate: +72.000000
South_Bounding_Coordinate: -15.000000
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: Line Feature
Theme_Keyword: Feature Identifier
Theme_Keyword: Census Feature Class Code (CFCC)
Theme_Keyword: Address Range
Theme_Keyword: Geographic Entity
Theme_Keyword: Point/Node
Theme_Keyword: Landmark Feature
Theme_Keyword: Political Boundary
Theme_Keyword: Statistical Boundary
Theme_Keyword: Polygon
Theme_Keyword: County/County Equivalent
Theme_Keyword: TIGER/Line
Theme_Keyword: Topology
Theme_Keyword: Street Centerline
Theme_Keyword: Latitude/Longitude

Theme_Keyword: ZIP Code
Theme_Keyword: Vector
Theme_Keyword: TIGER/Line Identification Number (TLID)
Theme_Keyword: Street Segment
Theme_Keyword: Coordinate

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    Place:
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        FIPS Publication 55
      Place_Keyword: United States
      Place_Keyword: Puerto Rico
      Place_Keyword: County
  Access_Constraints: None
  Use_Constraints:
    None.  Acknowledgment of the U.S. Bureau of the Census would be appreciated for
    products derived from these files.  TIGER, TIGER/Line, and Census TIGER are
    registered trademarks of the Bureau of the Census.
  Native_Data_Set_Environment:
    TIGER/Line files are created and processed in a VMS environment.  The
environment
    consists of two Alpha Server 8400s clustered together running OpenVMS version
    6.2-1H3 used for production operations.  The Census TIGER system is driven by
    DEC Command language (DCL) procedures which invoke C software routines to
extract
    selected geographic and cartographic information (TIGER/Line files) from the
    operational Census TIGER data base.
Data_Quality_Information:
  Attribute_Accuracy:
    Attribute_Accuracy_Report:
      Accurate against Federal information Processing Standards
      (FIPS), FIPS Publication 6-4, and FIPS-55 at the 100% level for the codes and
base
      names.  The remaining attribute information has been examined but has not been
fully
      tested for accuracy.
  Logical_Consistency_Report:
    The feature network of lines (as represented by Record Types 1 and 2) is compete
    for census purposes.  Spatial objects in TIGER/Line belong to the "Geometry and
    Topology" (GT) class of objects in the "Spatial Data Transfer Standard" (SDTS)
    FIPS Publication 173 and are topologically valid.  Node/geometry and topology
    (GT)-polygon/chain relationships are collected or generated to satisfy
topological
    edit requirements.  These requirements include:
    * Complete chains must begin and end at nodes.
    * Complete chains must connect to each other at nodes.
    * Complete chains do not extend through nodes.
    * Left and right GT-polygons are defined for each complete chain element and are
    consistent throughout the extract process.
    * the chains representing the limits of the files are free of gaps.
    The Census Bureau performed automated tests to ensure logical consistency and
limits
    of files.  All polygons are tested for closure.  The Census Bureau uses its
internally
    developed Geographic Update System to enhance and modify spatial and attribute
data in
    the Census TIGER data base.  Standard geographic codes, such as FIPS codes for
states,
    counties, municipalities, and places, are used when encoding spatial entities.
The
    Census Bureau performed spatial data tests for logical consistency of the codes
during
    the compilation of the original Census TIGER data base files.  Most of the Codes
    themselves were provided to the Census Bureau by the USGS, the agency
responsible for
    maintaining FIPS 55. Feature attribute information has been examined but has not
been
    fully tested for consistency.
```

Completeness_Report:
Data completeness of the TIGER/Line files reflects the contents of the Census TIGER
data base at the time the TIGER/Line files (Redistricting Census 2000 version) were
created.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
The information present in these files is provided for the purposes of statistical
analysis and census operations only. Coordinates in the TIGER/Line files have six
implied decimal places, but the positional accuracy of these coordinates is not as
great as the six decimal places suggest. The positional accuracy varies with the
source materials used, but generally the information is no better than the established
national map Accuracy standards for 1:100,000-scale maps from the U.S. Geological
Survey (USGS); thus it is NOT suitable for high-precision measurement applications
such as engineering problems, property transfers, or other uses that might require
highly accurate measurements of the earth's surface. The USGS 1:100,000-scale maps
met national map accuracy standards and use coordinates defined by the North
American Datum, 1983. For the contiguous 48 States, the cartographic fidelity of
most of the Redistricting Census 2000 TIGER/Line files, in areas outside the
1980 census Geographic Base File/Dual Independent map Encoding (GBF/DIME) file
coverage and selected other large metropolitan areas, compare favorable with the
USGS 1:100,000-scale maps. The Census Bureau cannot specify the accuracy of
features inside of what was the 1980 GBF/DIME-File coverage or selected metropolitan
areas. The Census Bureau added updates to the TIGER/Line files that enumerators
annotated on maps sheets prepared from the Census TIGER data base as they attempted
to traverse every street feature shown on the Census 2000 map sheets; the Census
Bureau also made other corrections from updated map sheets supplied by local
participants for Census Bureau programs. The locational accuracy of these updates
is of unknown quality. In addition to the Federal, State, and local sources,
portions of the files may contain information obtained in part from maps and
other materials prepared by private companies. Despite the fact the TIGER/Line
data positional accuracy is not as high as the coordinate values imply, the
six-decimal place precision is useful when producing maps. The precision allows
features that are next to each other on the ground to be placed in the correct
position, on the map, relative to each other, without overlap.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator:

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          U.S. Department of Commerce
          Bureau of the Census
          Geography Division
        Publication_Date: Unpublished material
        Title: Census TIGER data base
        Edition: Redistricting Census 2000
      Type_of_Source_Media: On line
      Source_Time_Period_of_Content:
        Time_Period_Information:
          Single_Date/Time:
            Calendar_Date: 2000
        Source_Currentness_Reference: Date the file was made available to create
TIGER/Line File extracts.
      Source_Citation_Abbreviation: TIGER
      Source_Contribution:
        Selected geographic and cartographic information (line segments) from
        the Census TIGER data base.
    Process_Step:
      Process_Description:
        In order for others to use the information in the Census TIGER data base in
        a GIS or for other geographic applications, the Census Bureau releases
periodic
        extracts of selected information from the Census TIGER data base, organized
as
        topologically consistent networks.  Software (TIGER DB routines) written by
the
        Geography Division allows for efficient access to Census TIGER system data.
        TIGER/Line files are extracted from the Census TIGER data base by county or
        statistical equivalent area.  Census TIGER data for a given county or
statistical
        equivalent area is then distributed among 17 fixed length record ASCII
files, each
        one containing attributes for either line, polygon, or landmark geographic
data
        types.  The Census Bureau has released various versions of the TIGER/Line
files
        since 1988, with each version having more updates (feature and feature
names,
        address ranges and ZIP Codes, coordinate updates, revised field definitions,
etc.)
        than the previous version.
      Source_Used_Citation_Abbreviation: Census TIGER data base
      Process_Date: 2000
Spatial_Data_Organization_Information:
  Indirect_Spatial_Reference:
    Federal Information Processing Standards (FIPS) and feature names
    and addresses.
  Direct_Spatial_Reference_Method: Vector
  Point_and_Vector_Object_Information:
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Node, network
      Point_and_Vector_Object_Count: 570 to 56,000
      SDTS_Point_and_Vector_Object_Type: Entity point
      SDTS_Point_and_Vector_Object_Type: Complete chain
      Point_and_Vector_Object_Count: 790 to 83,000
      SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
      Point_and_Vector_Object_Count: 290 to 33,000
Spatial_Reference_Information:
  Horizontal_Coordinate_System_Definition:
    Geographic:
      Latitude_Resolution: 0.000458
      Longitude_Resolution: 0.000458
      Geographic_Coordinate_Units: Decimal degrees
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Entity_and_Attribute_Information:
  Overview_Description:
    Entity_and_Attribute_Overview:
      The TIGER/Line files contain data describing three major
      types of features/entities;
      Line Features -
      1) Roads
      2) Railroads
      3) Hydrography
      4) Miscellaneous transportation features and selected power lines and pipe
lines
      5) Political and statistical boundaries
      Landmark Features -
      1) Point landmarks, e.g., schools and churches.
      2) Area landmarks, e.g., Parks and cemeteries.
      3) Key geographic locations (KGLs), e.g., shopping centers and factories.
      Polygon features -
      1) Geographic entity codes for areas used to tabulate the Census 2000 census
      statistical data and 1990 geographic areas
      2) Locations of area landmarks
      3) Locations of KGLs
      The line features and polygon information form the majority of data in the
TIGER/Line
      files.  Some of the data/attributes describing the lines include coordinates,
feature
      identifiers (names), CFCCs (used to identify the most noticeable
characteristic of a
      feature), address ranges, and geographic entity codes.  The TIGER/Line files
contain
      point and area labels that describe landmark features and provide locational
reference.
      Area landmarks consist of a feature name or label and feature type assigned to
a polygon
      or group of polygons.  Landmarks may overlap or refer to the same set of
polygons.
      The Census TIGER data base uses collections of spatial objects (points, lines,
and
      polygons) to model or describe real-world geography.  The Census Bureau uses
these
      spatial objects to represent features such as streets, rivers, and political
boundaries
      and assigns attributes to these features to identify and describe specific
features
      such as the 500 block of Market Street in Philadelphia, Pennsylvania.
    Entity_and_Attribute_Detail_Citation:
      U.S. Bureau of the Census, TIGER/Line files,
      Redistricting Census 2000 Technical Documentation.  The TIGER/Line
documentation
      defines the terms and definitions used within the files.
Distribution_Information:
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        Contact_Organization:
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          Bureau of the Census
          Geography Division
          Products and Services Staff
      Contact_Address:
        Address_Type: Physical address
        Address: 8903 Presidential Parkway, WP I
        City: Upper Marlboro
        State_or_Province: Maryland
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          Postal_Code: 20772
        Contact_Voice_Telephone: (301) 457-1128
        Contact_Address:
          Address_Type: Mailing address
          Address: Bureau of the Census
          City: Washington
          State_or_Province: District of Columbia
          Postal_Code: 20233-7400
        Contact_Voice_Telephone: (301) 457-1128
        Contact_Facsimile_Telephone:
          (301) 457-4710
          Contact_Electronic _Mail_Address: tiger@census.gov
    Resource_Description: Redistricting Census 2000 TIGER/Line Files
    Distribution_Liability:
      No warranty, expressed or implied is made and no liability is
      assumed by the U.S. Government in general or the U.S. Census Bureau in specific
  as
      to the positional or attribute accuracy of the data.  The act of distribution
  shall
      not constitute any such warranty and no responsibility is assumed by the U.S.
      Government in the use of these files.
    Standard_Order_Process:
      Digital_Form:
        Digital_Transfer_Information:
          Format_Name: TGRLN (compressed)
          Format_Version_Number: Redistricting Census 2000
          Format_Version_Date: 2000
          File_Decompression_Technique: PK-ZIP, version 1.93A or higher
        Digital_Transfer_Option:
          Online_Option:
            Computer_Contact_Information:
              Network_Address:
                Network_Resource_Name: www.census.gov/geo/www/tiger
      Fees:
        The online copy of the TIGER/Line files may be accessed without charge.  See
        http://www.census.gov/geo/www/tiger for information on availability on
  CD-ROM/DVD
        and associated costs for these products.
      Ordering_Instructions:
        To obtain more information about ordering TIGER/Line files visit
        http://www.census.gov/geo/www/tiger.
        Technical_Prequisites: The Redistricting Census 2000 TIGER/Line files contain
  geographic
        data only and do not include display or mapping software or statistical data.
  A
        list of vendors who have developed software capable of processing TIGER/Line
  files
        can be found by visiting http://www.census.gov/geo/www/tiger
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            Bureau of the Census
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          City: Upper Marlboro
          State_or_Province: Maryland
```

Postal_Code: 20772
Contact_Voice_Telephone: (301) 457-1128
Contact_Electronic_Mail_Address: tiger@census.gov
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: 19940608

EID/GWH-86/2

IMPACTS OF URANIUM MINING ON SURFACE AND SHALLOW GROUND WATERS GRANTS MINERAL BELT, NEW MEXICO

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SEPTEMBER, 1986

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3. Evaluation of hydraulic relationships between surface waters and shallow ground waters in the two districts.

4. Characterization of chemical and hydraulic impacts of mine dewatering effluents on surface waters and shallow ground waters in the two districts.

5. Analysis of the vulnerability of shallow ground waters in the two districts to contamination from uranium industry activities.

6. Characterization of the quality of runoff from uranium mine waste piles.

The second goal of this assessment is to develop recommendations for the solution of identified problems. Strategies evaluated for controlling pollution from uranium mining sources are

1. Application of the federal National Pollutant Discharge Elimination System (NPDES) permits and of state surface and ground water quality regulations to address water pollution problems in the Grants Mineral Belt.

2. Use of the Resource Conservation and Recovery Act (RCRA) and the federal "Superfund" to mitigate uranium mining impacts on water quality.

3. Use of state radiation protection regulations as water pollution control tools.

4. Use of land treatment practices to prevent nonpoint source pollution from uranium mine waste piles.

2.3 AREAL DESCRIPTION

2.3.1. Location and Major Features

The Grants Mineral Belt is an approximately rectangular area in northwest New Mexico, encompassing portions of McKinley, Cibola, Sandoval, and Bernalillo counties. The Mineral Belt is approximately 100 miles long and 25 miles wide (Figure 2.1). The name "Mineral Belt" refers primarily to the uranium ore found in this area. Locations of uranium mining areas within the Mineral Belt are indicated on the map.

The Belt encompasses portions of the Laguna and Canoncito Reservations along its southeast extent, and a corner of the Navajo Reservation at its northwest extent. Interstate-40 lies to the south of the Mineral Belt; located along I-40 are the local population centers of Grants-Milan and Gallup. Smaller communities in the area include Crownpoint, San Mateo, and Laguna. Just north of the Grants Mineral Belt is Chaco Canyon, a National Monument noted for its ancient pueblo ruins.

Major topographic features in the area include the Zuni Mountains southeast of Gallup, the Cebolleta Mountains in the southeast corner of McKinley County, and Mount Taylor northeast of Grants. The Continental Divide cuts approximately through the middle of the Belt, with stream courses to the east (e.g., Rio Paguate, Rio Moquino, and San Mateo Creek) being part of the Rio Grande drainage and stream courses to the west (e.g. Puerco River, and Coyote Wash) part of the Colorado River drainage. Characteristic landforms include rugged mountains, broad, flat valleys, mesas, cuestas, rock terraces, steep escarpments, canyons, lava flows, volcanic cones, buttes, and arroyos.

2.3.2. Climate and Vegetation

The climate in the region is arid to semiarid. Annual precipitation is 20-to-30 inches in the mountain areas and 8-to-10 inches in the lower areas. The majority of precipitation occurs in the summer as brief, intense thunderstorms. Mountain areas usually receive significant amounts of snow in the winter. Evaporation exceeds precipitation throughout the region.

Potential evapotranspiration is more than 30 inches of water in an average year. Because less than 17 inches of precipitation on the average is received annually, there is a large net water deficit. Although small water surpluses occur in winter (December thru February), large water deficits are incurred during the remainder of the year. The deficit is greatest during the warm growing season months of June through September.

Vegetation of the region is typical of that of other semiarid climates of the Southwest. Most of the low-lying area is grassland with some cacti and yucca. Pinon and juniper are the dominant trees found on upland and north-facing slopes. Ponderosa pines and firs are found in the high mountain areas. In much of the valley areas, vegetation is insufficient to prevent erosion. Riparian vegetation along stream courses is limited; where it does occur, it consists primarily of cottonwood and salt cedar trees.

2.3.3. Geology

The Belt lies along the southern edge of the San Juan Basin, which is in the eastern part of the Colorado Plateau physiographic province. It is a region of scarped tablelands with broad valleys, and local canyons cut in Mesozoic and younger sedimentary rocks (Stone and others, 1983). The rocks are comprised principally of alternating shales and sandstones and some limestones.

Primary structural geologic features in the Grants Mineral Belt area are the Chaco Slope, Zuni Uplift, and Acoma Sag (Figure 2.2). Along the Chaco Slope, Cretaceous and Tertiary rocks out crop. Mesozoic and Upper Palezoic sediment and Precambrian igneous and metamorphic rocks are exposed in the Zuni Uplift (Stone and others, 1983). These strata dip to the northeast toward the basin axis. Figure 2.3 is a cross-section of the San Juan Basin; the Grants Mineral Belt falls in the region between the southwest edge and Crownpoint. Figure 2.4 is a stratigraphic column of the underlying geologic formations in the principal mining districts.

Of significance to this study is the Morrison Formation, of Upper Jurassic age. In descending order, it consists of the Brushy Basin member, the Westwater Canyon member, and the Recapture member. The Westwater Canyon member is host to the major uranium ore deposits and also to a major aquifer of the Grants Mineral Belt. It consists of interbedded fluvial arkosic sandstone, claystone, and mudstone. Its average thickness is 250 feet, but it thins to 100 feet southward and eastward. The Brushy Basin member, which overlies the Westwater, consists of a relatively impervious shale. Included in the Brushy Basin member, is the Jackpile Sandstone which bears the uranium ore body that is mined near Laguna and the Poison

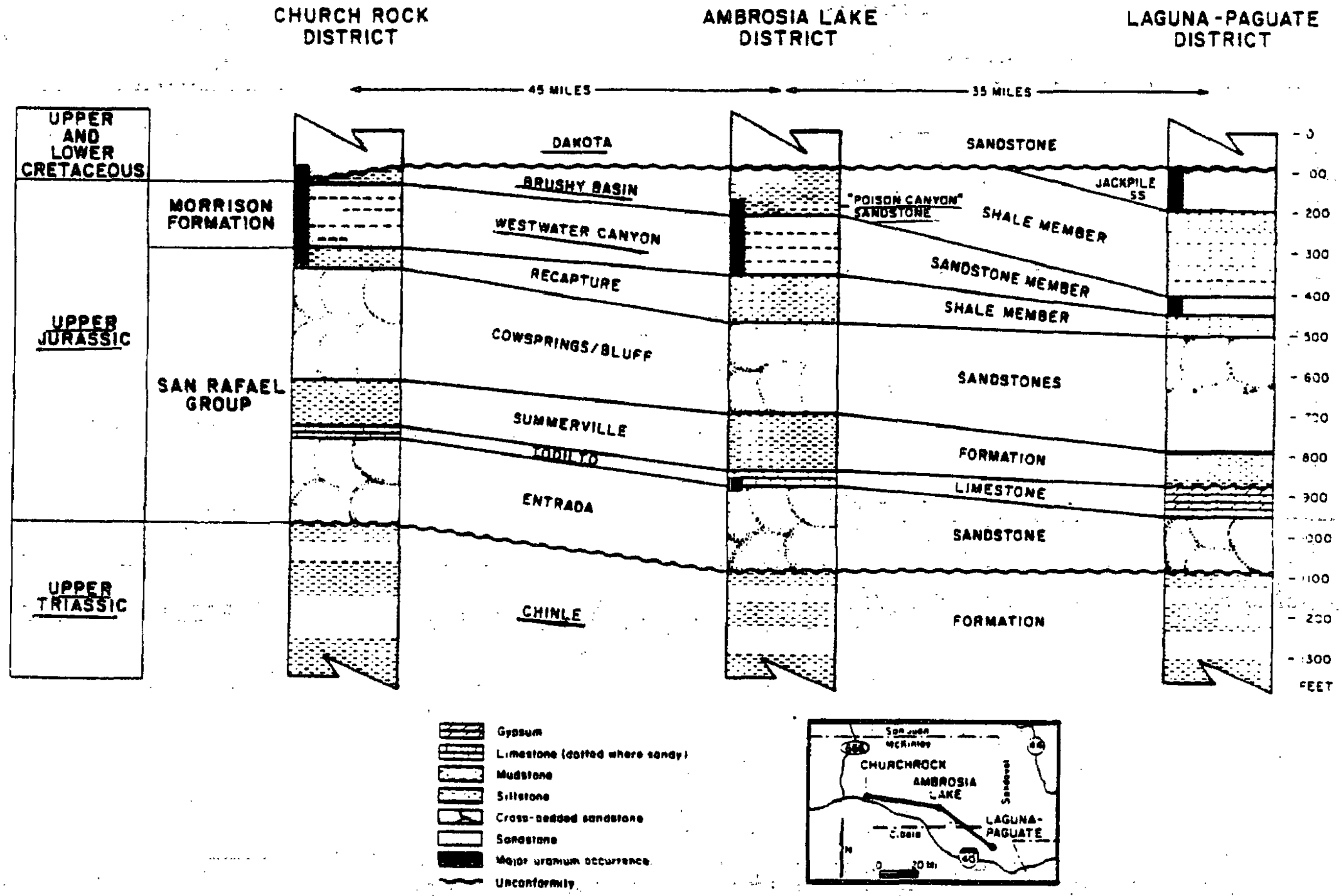


FIGURE 2.4 Stratigraphic sections of the Church Rock, Ambrosia Lake, and Laguna-Paguate mining district (after N.M. Energy and Minerals Dept., 1984).

Canyon Sandstone which bears uranium that is mined near Grants. The average thickness of the Brushy Basin member is 185 feet; toward the southwest part of the San Juan Basin, in the vicinity of Gallup, the Brushy Basin member is absent. Underlying the Morrison Formation is the San Raphael Group which includes the Todilto Limestone, a uranium bearing unit that is mined near Grants.

The Dakota Sandstone is a Lower Cretaceous formation overlying the Morrison Formation. It consists of massive quartz sandstone interbedded with coal lenses. In the southwest part of the San Juan Basin, where the Brushy Basin member is absent, the Dakota Sandstone and Westwater Canyon member form a single hydrologic unit.

Much of the emphasis of this study is on the relatively thin veneers of Quaternary unconsolidated to semi-consolidated alluvial, eolian, and terrace deposits that overlie the consolidated rock units in the valley bottoms. These deposits are predominantly silty or clayey fine sand, with occasional concentrations of coarse sand or gravel. Alternating periods of erosion and deposition have resulted in marked disconformities within the alluvium (Leopold and Snyder, 1951). Thickness of the alluvial deposits in the area of concern is usually less than 200 feet.

2.3.4. Water Resources

Surface Water.

Prior to uranium mining and discharge of dewatering effluents, most streams in the Grants Mineral Belt area were ephemeral. Peak flows occurred in the late summer, during heavy thunderstorms. Somewhat less intense flows also occurred in the late winter and early spring, due to melting of snow in the mountains. Because vegetation in the area is insufficient to impede erosion, runoff from these waters carries a heavy sediment load.

The only significant naturally perennial waters are a few small springs along the Puerco River, and streams draining the flanks of Mt. Taylor. The most significant of the perennial streams are Rio Paguate and Rio Moquino which drain the northeast slope of Mt. Taylor and traverse the Laguna-Paguate mining district (see Figure 2.1). Since construction of San Mateo Reservoir, San Mateo Creek has flowed continuously near the community of San Mateo, located on the northwest side of Mt. Taylor in the Ambrosia Lake district. Because of streamflow losses, however, San Mateo Creek normally becomes ephemeral within one mile below San Mateo.

The water in these channels is eventually lost to evaporation and infiltration to shallow alluvial aquifers. Recharge of bedrock aquifers also occurs in short stretches where the streams intersect bedrock outcrops.

Ground Water.

As stated previously, the Westwater Canyon member of the Morrison Formation is a principal aquifer in the area, with yields to wells of up to several hundred gallons per minute. Reliable water supplies are also available from the Gallup Sandstone, the Dakota Sandstone, the Glorieta Sandstone, and the San Andres Limestone. Dewatering of uranium mines has resulted in a significant decline in water levels in the aquifers tapped (mainly the Morrison Formation) and in adjacent formations

Other aquifer systems occur in the unconsolidated valley fills (alluvium) along the San Mateo Creek and the Puerco River, with yields to wells usually less than fifty gallons per minute. The alluvial deposits range from 0 to about 170 feet in thickness; water is found anywhere from a few feet to 100 feet below the surface. Recharge of the alluvial aquifers occurs both from infiltration of surface flow and from bedrock discharges in the form of seeps and springs.

Alluvial ground water-level maps for the Puerco River and the San Mateo Creek valleys are shown in Figures 2.5 and 2.6, respectively. The general direction of alluvial ground water flow in both valleys is to the southwest, corresponding to the slope of the land surface.

Water Use.

Historically, the principal uses of water in the Grants Mineral Belt have been domestic use and livestock watering. Domestic and municipal wells tap both alluvial and bedrock aquifers throughout the area. Numerous shallow domestic

wells are located around the municipalities of Milan and Gallup. Milan derives its municipal water supply from wells tapping the San Andres Limestone. The adjacent community of Grants produces municipal water from wells tapping basalt, alluvium, the San Andres Limestone, and the Glorieta Sandstone. Most of the water supply for the City of Gallup comes from the Gallup Sandstone. Crownpoint derives its water supply from the Morrison Formation. Water for livestock is primarily derived from the shallow alluvial aquifer.

Irrigated agriculture is limited, but occurs to some extent along the valleys of Bluewater Creeks the Rio San Jose, and San Mateo Creek, and along the North Fork of Puerco River from the state road 566 bridge downstream to Gallup (see Figure 3.1). The main crops are vegetables and forage.

The advent of uranium mining has brought support industries which utilize ground water to some extent to the area; examples include cement and caustic soda plants. Moreover, large amounts of ground water are pumped from the uranium mines and discharged to surface watercourses or utilized by uranium mills.

Use of surface water has been limited due to its predominantly ephemeral nature. The discharge of mine dewatering effluents, however, has caused the now perennial streams to become important livestock water supplies.

2.3.5. Land Use

The Grants Mineral Belt is a complex mixture of Indian reservations and Federal, state, and private lands. The land is primarily used for livestock grazing by Indian and private ranchers. Logging occurs to a small extent in the mountain areas. In the Gallup area, coal mining has occurred since the 1880s.

Uranium mining began in the 1950s. The uranium companies have both leased lands from the Federal government, the state, and Indians tribes, and bought some lands outright.

2.4 HISTORY OF THE URANIUM INDUSTRY IN THE STUDY AREA

Four mining districts have been developed within the Grants Mineral Belt, and are, from east to west, the Laguna-Paguate, Ambrosia Lake, Smith Lake, and the Church Rock mining districts (see Figure 2.1). There has been extensive exploration and new mine development in areas such as the Crownpoint, Nose Rock, and Marquez.

Extraction of uranium ore from the Laguna-Paguate and Ambrosia Lake mining districts began in the early 1950s using strip and open-pit mining methods. At that time most of the ores were extracted from sandstones of the Morrison Formation in the Laguna-Paguate district and the Todilto limestone in Ambrosia Lake district (see Figure 2.4). By 1954, the Laguna-Paguate district had become host to the largest open pit uranium mine in the United States, the Jackpile-Paguate mine (NM Energy and Minerals Department, 1981). By its closure in 1980, over 2700 acres of land had been disturbed (U.S. Department of the Interior, 1980). As late as 1979, the Jackpile-Paguate mine contributed more than 40% of the uranium ore mined in the Grants Mineral Belt (NM Energy and Minerals Department, 1981).

After the initial discovery of uranium in the Todilto limestone in 1950, numerous open-pit mines dotted the landscape of Ambrosia Lake where the limestone was exposed near the ground surface. Drilling downdip from the initial surface discoveries led to the delineation of ore bodies within the Poison Canyon and Westwater Canyon members of the Morrison Formation (see Figure 2.4 for detailed descriptions of units).

Eventual discovery of large subsurface deposits within the Westwater Canyon member established the Ambrosia Lake mining district as a major uranium production area. In 1980, the Ambrosia Lake mining district contained over two-thirds of the active uranium mines in the state (NM Energy and Minerals Department, 1981). Virtually all of these mines are underground with depths averaging approximately 900 feet. Several major aquifers are penetrated by these shafts.

Delineation and development of ore bodies in the Church Rock mining district began in 1965. Zones of mineralization are recognized at depths exceeding 1800 feet with average shaft depths of approximately 1600 feet. Several major water-bearing strata also are penetrated by the Church Rock mine shafts. As is the present case in Ambrosia Lake, mining in the Church Rock area is conducted by the room and pillar method. This involves mining out blocks of ore while leaving adjacent pillars of ore or waste as support for the roof (Figure 2.7). The size of the rooms depends on the strength of the roof.

Activities of the New Mexico uranium mining industry peaked in 1978-80, following a world wide shortage of the metal and increasing demands for the metal as a electrical power generation fuel. At present, however, the industry is experiencing a severe decline. The following table summarizes the severity of this decline:

CATEGORY	1977-78[a]	1983[b]
Active Mines	40	13
Active Mills	5	2
Employment	8,000	1,533
Share of total U.S. production	46%	24%

a Chris Wentz, NM Energy and Minerals Department, personal communication (1983)

b NM Energy and Minerals Department (1984).

2.5 OVERVIEW OF URANIUM MINING OPERATIONS

Surface (open-pit) mining and underground mining have accounted for virtually all of the uranium mined in New Mexico. Solution mining has been found to be successful in pilot test projects, but commercial application of the technique has yet to have an impact on New Mexico's industry. Total production from surface and underground mines has been nearly equal.

Both types of mines contribute waste to natural surface drainage systems. Solid wastes are derived from both types while liquid wastes are almost exclusively derived from underground mines.

In the surface mining method,the topsoil and overburden overlying the ore are removed and stockpiled. The uranium ore is then removed and stored prior to shipment to a milling facility. Occasionally, berms and ditches are constructed around the waste and storage piles to control runoff from the piles as well as to divert upstream flood waters away from the piles.

As the mine is further developed, the overburden may be backfilled to fill mined-out areas of the pit. Ultimately, the mined area may be graded and seeded to restore the land surface to its pre-mined condition. Few active or inactive mines have been even marginally reclaimed.

Ore bodies that are located more than about one hundred feet below the land surface are accessed by vertical shafts (see Figure 2.7) The mine extends laterally from the vertical shafts, sometimes for distances greater than a mile.

Because underground mines are developed in a way that minimizes the amount of waste rock removed, far less solid waste is produced than in a surface mine. In terms of contaminant concentrations, however, the underground mine waste rock can be more enriched and can be of greater concern than surface mine waste rock. Underground waste rock is stored in a spoils area that may be, but usually is not, bermed to control runoff.

Since most of the deeper ore bodies lie beneath major bedrock aquifers, dewatering operations are required. Most of the produced water in the Grants Mineral Belt is pumped from within the mines and discharged to settling ponds and to drainage channels. Water also can be pumped from wells that are drilled into the water-bearing strata near the mine in an effort to depressurize the aquifer.

To comply with effluent limitations specified by the federal National Pollutant Discharge Elimination System (NPDES) permits, most mines treat water. Prior to discharge, a flocculant and barium chloride are added to reduce suspended solids concentrations and to coprecipitate radium. Elevated concentrations of dissolved uranium are reduced by a separate ion-exchange treatment.

The average underground mine in the Grants Mineral Belt continuously discharges more than 1000 gallons per minute of produced water. Collectively, more than 150 billion gallons of water were pumped from aquifers in the Grants Mineral Belt between 1956 and 1982 (Perkins and Goad, 1980). Lyford and others (1980) provide a comprehensive assessment of the hydrologic effects on the aquifer system of this sustained pumping. Local water-level declines in the Morrison Formation in excess of 500 feet have resulted from the dewatering.

III. METHODS AND APPROACH

Monitoring activities for this assessment were centered on the three major active mining districts in the Grants Mineral Belt: Laguna-Paguate, Ambrosia Lake, and Church Rock. In the former district, monitoring focused on characterization of natural surface water quality and the effects of open-pit uranium mining on surface water quality. In the latter two districts, monitoring involved characterization of the quality of both natural surface waters and natural ground waters and of the impacts of uranium mining activities on these waters. Instrumentation was installed at sites along representative stream segments in each of the two districts in order to characterize hydraulic and contaminant migration relationships between surface water and shallow ground-water flow systems. Water samples were collected and analyzed for general water-quality constituents as well as parameters specifically associated with uranium mining and milling. In all, over 440 samples were collected at a total of 74 monitoring stations. Chemical analyses of these samples have provided a body of over 10,000 data points.

Section 3.1 describes the monitoring locations for surface water and ground water and for runoff. This section also describes the types of data collected at each site and the frequency of water sampling and hydrological measurements. Section 3.2 explains the methodologies used to collect water quality samples, field data collection, and hydrological measurements. The water-quality constituents monitored and analytical methods for their determination are described in section 3.3. Data interpretation methods are reviewed in section 3.4. The actual data and interpretation of their significance are the subject of the remaining chapters of this report.

3.1 MONITORING SITE LOCATIONS AND INSTRUMENTATION

3.1.1 Surface Water

Monitoring at these stations began in 1977 and continued through 1982. Table 3.1 lists these stations; the stations locations are shown in Figures 3.1, 3.2, and 3.3. Most of these sites had continuous flow during the assessment. Flow at the Puerco River, San Mateo Creek at U.S. Geological Survey (USGS) gage, and the Arroyo del Puerto stations was attributable predominantly to the discharge of uranium mine dewatering effluents. Flow at San Mateo Creek at San Mateo Reservoir, and Rios Moquino and Paguate stations, on the other hand, was naturally perennial and not augmented by dewatering effluents. The two Arroyo del Puerto stations actually function as one station; the "Kerr-McGee cattails" site was sampled when there was no flow at the USGS gage site.

In addition to the stations listed in Table 3.1, a number of sites were sampled (1) during runoff events, and (2) along the Puerco River during and after the United Nuclear Corporation (UNC) uranium mill tailings spill on July 16, 1979. A detailed analysis of the consequences of this spill is presented in a separate report (Gallaher and Cary, 1986).

Through sampling efforts distinct from this assessment, EID staff have collected one grab sample per year from most uranium industry point sources. In 1980 and 1981, uranium industry point source discharges and the assessment stations were sampled concurrently.

Water Quality.

Surface water samples were collected at each monitoring station on a quarterly basis, and occasionally during runoff events. More frequent sampling was conducted at the two Puerco River stations after the UNC tailings spill: daily or every two days for two weeks after the event; weekly for another two weeks; monthly through July 1980; and finally quarterly.

Hydrology.

Five of the stations listed in Table 3.1 are equipped with surface-flow gages. Gage 08349800, the Rio Paguate station below the Jackpile Mine, had been installed by the USGS in 1976 as part of their routine water measurement effort. The other four gages were installed, operated, and maintained by the USGS specifically for this study under funding from the EID. The USGS found that the site initially chosen at the Highway 566 bridge on the Puerco River was not favorable for obtaining accurate measurements or continuous records, because the channel is quite unstable at that location. Consequently, this station was moved in 1980 to a more favorable site a few miles downstream. Flow records for all five stations are summarized in the annual USGS publication, "Water Resources Data, New Mexico". (Water Data Report NM-76-1 to NM-82-1).

Instantaneous flow measurements at ungaged surface-water stations were taken while collecting water samples. Measurements were made with a Price pygmy meter according to procedures detailed by the U.S. Department of the Interior (1977).

3.1.2. Ground Water

Cluster Concept.

The purpose of ground-water monitoring was to study the hydrologic and water quality relationships between surface and ground water and to evaluate the movement of contaminants in the alluvial aquifer. The monitoring well clusters are designed to detect the early stages of contamination of the aquifer.

Figure 3.4 illustrates an idealized well cluster. One well is drilled about 10 feet from the channel edge to a deph of about 35 feet. Another well is drilled adjacent to the first, but about 70 feet deep. These two wells enable sampling of the aquifer at the same location, but at different depths. For some clusters, a single boring was drilled, but cased and perforated so that it can actually function as two wells -- one shallow and one deep. The well is given one number and the two depths are distinguished by putting a "U" for "upper" or an "L" for "lower" after the well number. A third well is placed about 200 feet upstream of the first, 10 feet from the channel edge and drilled to a depth of 35 feet. A final 35-foot-deep well is placed 200 feet from the first in a direction perpendicular to the channel. Thus the cluster design enables determination of water-quality differences along the stream channel, away from the stream channel, and at different depths in the aquifer. Not every cluster was constructed as shown in Figure 3.4, but only one cluster has less than two wells.

Locations of the ten cluster sites for this study are shown on Figures 3.1 and 3.2. Table 3.2 lists additional information for each well, such as depth, casing diameter, and screened interval. Well locations are described in accordance with New Mexico State Engineer Office procedures, illustrated on Figure 3.5. Gallup, Lee, Sandoval, Otero, and Roundy clusters were installed in 1977-1978, while additional clusters, Entrada, Windmill, Springstead, Confluence, and BLM, were installed in 1981. Gal-5 was drilled in 1980 in order to further investigate the UNC tailings spill impacts at that site.

All monitoring wells were installed with either air rotary or hollow-stem auger drilling rigs. To avoid introducing contaminants into the wells, no drilling muds or fluids were added during the drilling operation. PVC plastic was selected as well casing material.

Water Quality.
Ground water samples were collected quarterly, concurrent with collection of surface water samples. Additionally, for a year after the UNC tailings spill, the Gallup cluster was sampled on a monthly basis.

Hydrology.
A water-level recorder (continuous-reading) was installed on a single well at each of the original five clusters. As water-level readings at the Gallup cluster indicated that there is little water-level fluctuation along the Puerco River, continuous recorders were not installed at the Entrada, Windmill, Springstead, and Confluence sites. A recorder was installed at the BLM well cluster, however, because of its location above the river stretch receiving dewatering effluent. Water-level measurements were taken with a steel tape on all gaged wells monthly when the chart was changed on the recorders. The steel protective casings of the wells at each cluster were surveyed relative to one another, so that all water levels are measurements of relative depths within a cluster.

Short-term aquifer performance tests were performed on at least one well at each of the Puerco River clusters. Details on these tests are given in Gallaher and Cary (1986).

3.1.3. Runoff Sampling

Large quantities of materials associated with uranium ore are brought to the surface of the earth and deposited as mine tailings. These materials, when exposed to rainfall and snowmelt, have the potential to contaminate runoff with radionuclides and other trace elements associated with uranium mining. In 1982, a runoff sampling program was conducted to evaluate the runoff quality of these waste piles and the potential impact on surface and ground water quality in the region.

In order to sample the runoff, single-stage samplers were installed in tandem at a number of sites in ephermeral watercourses in ephemeral watercourses above and below mine waste piles (Table 3.3 and Figures 3.1 and 3.2). The sampler design was such that, when the water level of a runoff event reached a certain height, a sample of the runoff was collected in a quart bottle at the bottom of the sampler. The samplers were checked frequently by EID personnel during the summer of 1982; the longest period any sampler went unchecked was two weeks.

In addition to the single-stage samplers, grab samples were taken at miscellaneous sites above and below waste piles during runoff events. The locations and frequency of these samplings were dictated by the weather, by the presence of EID personnel, and by what seemed appropriate to the particular event and location.

3.1.4 Leach Tests.

In conjunction with the runoff sampling program, mine wastes themselves were subjected to leach tests in order to determine the potential for constituents to leach out of the waste piles and into runoff or ground water. Samples were collected from waste piles at the following six mine locations:

WASTE PILE LOCATION	NUMBER OF COMPOSITE SAMPLES*
United Nuclear Corporation-NE, Church Rock	4
Kerr McGee-I, Church Rock	4
Hyde	6
Vallejo	7
Poison Canyon	8
Old San Mateo	8

*See section 3.2.1.

The United Nuclear and Kerr-McGee sites had received mine wastes within the year before the time of sampling; the others sites were inactive or abandoned. Leach test methods are discussed in Section 3.3.3.

3.2 SAMPLING AND MEASUREMENT METHODOLOGIES

3.2.1. Water Quality

Field Data

Temperature, conductivity, and pH were measured in the field concurrent with collection of water samples. Temperature and conductivity were measured with a Yellow Springs Instruments model 33 S-C-T meter. Field pH was determined with a Hellige Color Comparator, if the sample was clear. Turbid samples were measured in the field with either an Orion pH meter or a Corning pH Meter. A two-point calibration was performed with standard pH buffers before each use of the meters.

Measurements of dissolved oxygen in ground water along the Puerco River were done to provide additional input data for a computer model utilized in the study (WATEQFC, see section 3.4.3). Measurements were taken twice on each 5-inch well with a Yellow Springs Instruments oxygen meter before and after pumping or sampling activities were initiated during a site visit. For these measurements the probe of the meter was lowered into the well so that it would be within the screened interval at the bottom of the well. The meter was calibrated with the Winkler method.

Surface Water Samples.

Grab samples were collected from the stream bank by hand-dipping water with a clean polyethlyene beaker from the stream into a 15-liter carboy. The polyethlyene, acid-washed carboys were rinsed with stream water prior to filling. The carboy samples were treated on-site as described below.

Ground Water Samples.

A truck-mounted electric submersible pump was used to collect samples from the five-

IV. NATURAL SURFACE WATER QUALITY IN THE GRANTS MINERAL BELT

EID sampling programs have provided quantification of the quality of natural surface waters that have been unaffected by uranium mining within the Grants Mineral Belt. These natural waters serve as a baseline against which the impact of uranium industry effluents can be evaluated. Since 1978, the EID has systematically sampled the few naturally perennial waters in the region. These data were augmented in 1982, when samples of snowmelt and thunderstorm runoff from ephemeral watercourses were collected. All natural surface water sampling sites were located upstream from uranium mining activities.

Three aspects of natural water quality are specifically addressed in this chapter. The first is the chemical quality of sediment-free water; that is, the concentrations of dissolved salts, trace elements, and radioactivity. The second aspect is the high sediment load that is typically carried by ephemeral streams in the Grants Mineral Belt during runoff events. Finally, the chemical and radiological quality of raw, unfiltered runoff is discussed. Sediment-laden runoff characteristically has large concentrations of trace elements and radionuclides.

4.1 PERENNIAL STREAMS

Under natural conditions, most watercourses in the Grants Mineral Belt flow only when sustained by snowmelt or storm runoff. Nonetheless, there are a few perennial watercourses in the three mining districts investigated in this regional assessment. Perennial waters in the Church Rock district are limited to a few small springs along the Puerco River. In the Ambrosia Lake district, San Mateo Creek has flowed continuously in the vicinity of the community of San Mateo since the construction of San Mateo Reservoir upstream. Both the Rio Paguate and the Rio Moquino, which originate on the well-vegetated northeast slope of Mount Taylor, are perennial. These streams flow into the Jackpile-Laguna district, converge, and as the Rio Paguate, complete the traverse of the district.

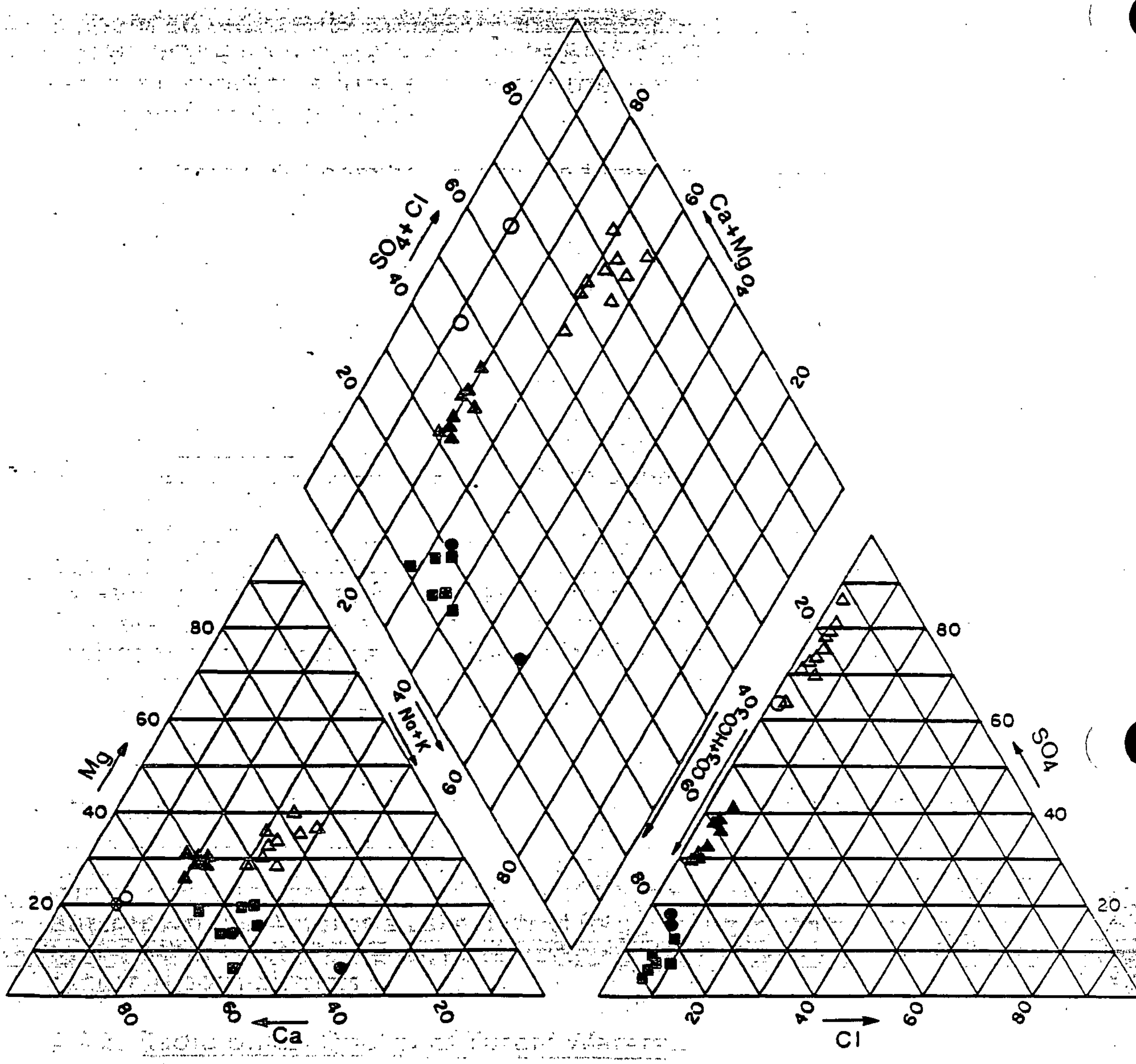
4.2 DISSOLVED SUBSTANCES

Dissolved salts in surface waters of the Grant Mineral Belt originate chiefly from weathered rocks and residues from evapotranspiration. Shale and limestone units are the primary geologic sources of dissolved solids in the region.

4.2.1. General Chemistry

Evaluation of sampling data shows that natural concentrations of the total dissolved solids in streams in the Grants Mineral Belt vary from less than 200 mg/l to over 1500 mg/l. The least saline waters are perennial San Mateo Creek and ephemeral flows in the South Fork of the Puerco River. The most saline water is found in the perennial Rio Moquino. The Mancos Shale, from which the Rio Moquino valley was excavated, has been shown to be one of the largest sources of salinity in the entire Colorado River Basin (Jackson and Julander, 1982).

A Piper diagram graphically illustrates the geochemical composition of different surface waters in the Grants Mineral Belt (Figure 4.1). Natural waters from the Rio



NATURAL SURFACE WATERS	TDS
● Puerco River South Fork at 566 bridge (ephemeral flow)	300
○ Puerco River North Fork at BLM (ephemeral flow)	580
■ San Mateo Creek at San Mateo (perennial stream)	180
▲ Rio Paguate above Jackpile (perennial stream)	490
△ Rio Moquino above Jackpile (perennial stream)	1530

FIGURE 4.1 Geochemical composition of natural surface waters, Grants Mineral Belt. Ions are expressed percentages of total equivalents per liter.

Moquino and ephemeral flows in the North Fork of the Puerco River are dominated by dissolved calcium and sulfate, which are abundant in the Mancos Shale. In contrast, South Fork of Puerco River and San Mateo Creek flow chiefly in limestone terrain and are enriched with bicarbonate ions. The perennial Rio Paguate has waters of chemical composition intermediate between these two types.

4.2.2. Trace Elements and Radioactivity

Dissolved trace element and radionuclide concentrations are very low in perennial streams in the Grants Mineral Belt. Dissolved concentrations in ephemeral flows are similarly very low, but may be slightly higher in line with the increased sediment loads (Table 4.1). Owing to the uniformly low concentrations found, the data are combined in Table 4.1 rather than presented by separate drainages or mining districts.

Dissolved concentrations of trace elements are usually quite low because existing natural compounds have low solubility under the neutral or slightly alkaline pH conditions common in the region and because the majority of dissolved trace elements in surface water become attached to sediment grains or form precipitates (Popp and Lacquer, 1980). Like the trace elements, most naturally occurring radionuclides are relatively insoluble.

4.3. SUSPENDED SEDIMENT

Suspended sediment levels in surface waters of the Grants Mineral Belt span a wide range of concentrations (Table 4.2). The few naturally perennial streams, such as Rio Moquino, Rio Paguate, and, locally, San Mateo Creek, are virtually sediment free, but most of the region is drained by dry arroyos that carry turbid flash floods after summer thunderstorm activity. The tremendous sediment concentrations of regional arroyos are among the world's highest (Gregory and Walling, 1973).

The majority of streamflows in watercourses in the Grants Mineral Belt are of the short-lived, turbid type. Maximum suspended sediment concentrations in these arroyos are many hundreds of thousands of milligrams per liter (mg/l) (Busby, 1979). The Puerco River exemplifies this type of stream. The name "puerco", which means "murky", has been applied to several regional streams that are "too thick to drink, to thin to plow."

The high suspended sediment concentrations are attributable to three major environmental factors. First, several geological strata in the region weather to silt and clay-sized particles that are easily carried in suspension by flowing water Important sediment-producing rock units are shales, including the Mancos Shale of the Puerco River Valley (Dane and Bachman, 1965; Jackson and Julander, 1982). Second, the semiarid climate prevents establishment of protective vegetative cover on the soil. In lowland areas the soil is sparsely vegetated with drought-resistant plants, including shrubs and bunch grasses. Overgrazing by livestock has rendered the ground surface even more vulnerable to erosion. Third, the late summer (July-September) rainy season brings intense thunderstorms that rapidly generate large volumes of runoff. Whether overland or in a channel, these flows readily entrain exposed sediment grains.

TABLE 4.1 Median Dissolved Concentrations of Trace Elements and Radioactivity in Natural Surface Waters. Number of samples given in parentheses.

CONSTITUENT	DISSOLVED CONCENTRATION Perennial Streams		Ephemeral Flows	
	(ug/l)			
As	<5	(39)	<5	(3)
Ba	100	(30)	<100	(3)
Cd	<1	(26)	<1	(3)
Pb	<5	(26)	<5	(3)
Mo	<10	(36)	<10	(8)
Se	<5	(39)	<5	(7)
U-natural	<5	(37)	10	(5)
V	<10	(29)	25	(3)
Zn	<50	(27)	<50	(3)
	(pCi/l)			
Gross alpha	2	(29)	17	(3)
Ra-226	0.1	(36)	1.2	(11)
Pb-210	1	(2)	4.5	(10)
Po-210	--	--	2.3	(7)
Th-238	--	--	0.3	(7)
Th-230	--	--	0.3	(7)
Th-232	--	--	0.2	(7)

4.4. CHEMICAL QUALITY OF TURBID WATERS

Suspended sediment can be a significant transport agent for chemical substances in water. In the ephemeral watercourses of the Grants Mineral Belt, high suspended sediment concentrations account for the major proportion of contaminant transport (see Keith, 1978).

4.4.1. Relation of Chemical Quality to Suspended Sediments

Data presented in Tables 4.3 and 4.4 illustrate the extreme variability in trace element and radionuclide levels in unfiltered waters. Concentrations of those constituents may range from below analytically detectable levels up to 1000 times greater than detectable levels.

Concentrations of most trace elements and radionuclides in turbid runoff demonstrate a strong, statistically significant dependence on the amount of sediment present in the sample. Regression analyses for individual constituents show that, in most cases, the amount of a particular constituent detected in an unfiltered water sample is a positive, linear, first-order function of total suspended sediment; correlation coefficients (r) are often greater than 0.90. In other words, each additional quantity of sediment added to surface water volume usually adds constant proportions of adsorbed or precipitated trace elements and radionuclides. The relation between the concentration of a particular constituent and the sediment concentration (i.e., the slope of a regression line) varies between drainages and depends chiefly on the elemental composition of rocks and sediments in the basins.

While data from the Ambrosia Lake mining district are limited, natural runoff in that district appears to be poorer in quality than runoff in the Church Rock district. In particular, the median concentrations of selenium and uranium in Ambrosia Lake runoff are 6 and 3 times greater, respectively, than in Church Rock runoff. These larger values are probably reflective of the abundance of uranium-ore-bearing outcrops in the Ambrosia Lake district (e.g., at the Poison Canyon mine). In contrast to the other trace elements, noteworthy is the virtual absence of molybdenum in runoff in both districts.

4.4.2. Radiological Quality of Turbid Waters

Radioactive substances were present in detectable concentrations in all of the runoff samples analyzed in this study. In the Ambrosia Lake mining district, gross alpha particle activity measurements of 5 samples ranged from 33 picocuries per liter (pCi/l) to 2100 pCi/l with a median concentration of 1200 pCi/l. Gross beta particle activity measurements of 4 samples ranged from 546 pCi/l to 2,000 pCi/l with a median concentration of 1,060 pCi/l. Slightly lower radioactivities were measured in 12 samples collected in the Church Rock mining district.

High radionuclide concentrations may be present in turbid flows throughout northwestern New Mexico, including the Grants Mineral Belt. Ephemeral washes draining northward from the Grants Mineral Belt into the San Juan Basin exhibit similar patterns of radioactivity to those within the drainages sampled. During turbid flow conditions, gross alpha and gross beta activities as high as several thousand pCi/l have been measured by the U.S. Geological Survey in the Chaco Wash

TABLE 4.2. Suspended Sediment Concentrations in Natural Surface Waters.

STREAM	SUSPENDED SEDIMENT CONCENTRATION (mg/l)			
	Log Mean	Min.	Max.	No. of Samples
Perennial Streams				
San Mateo Creek at San Mateo Reservoir	10	<1	83	7
Rio Moquino above Jackpile-Paguate Mine	14	<1	73	10
Rio Paguate above Jackpile-Paguate Mine	4	<1	59	12
Ephemeral Flows				
San Mateo Creek Drainage below San Mateo	8,100	940	32,000	4
Puerco River-South Fork Drainage	22,400	5,600	73,000	3
Puerco River-North Fork Drainage	55,700	3,700	561,000	3

TABLE 4[illegible] Total Trace Element Concentrations in Natur[illegible]unoff, 1982. All concentrations given in milligram[illegible]er liter (mg/l)

CONSTITUENT	AMBROSIA LAKE MINING DISTRICT (Based on 6 Samples)			CHURCH ROCK MINING DISTRICT (Based on 13 Samples)		
	MAX.	MIN.	MEDIAN	MAX.	MIN.	MEDIAN
As	0.26	0.05	0.13	0.30	0.02	0.08
Ba	43.5	1.4	7.7	9.6	0.44	4.8
Cd	0.05	0.003	0.006	0.06	0.001	0.003
Pb	2.0	0.05	0.52	2.0	0.01	0.17
Mo	<0.01	0.005	<0.01	0.02	<0.01	<0.01
Se	0.15	<0.005	0.03	0.03	<0.005	<0.005
U-natural	0.56	0.03	0.10	0.22	0.005	0.03
V	3.2	0.18	0.61	0.92	0.04	0.40
Zn	1.7	0.38	1.5	8.5	<0.05	0.38

samples in parentheses.

CONSTITUENT	AMBROSIA LAKE MINING DISTRICT MAX.	MIN.	MEDIAN	CHURCH ROCK MINING DISTRICT MAX.	MIN.	MEDIAN
Gross Alpha Activity	2,100	33	1,200 (5)	1,600	7	720 (12)
Gross Beta Activity	2,000	546	1,060 (4)	1,480	135	710 (9)
Pb - 210	720	4	88 (4)	74	0	53 (7)
Po - 210	43	---	--- (1)	450	9	80 (6)
Ra - 226	321	2	15 (4)	47	1	19 (9)
Th - 228	ND	ND	---	43	3	22 (7)
Th - 230	ND	ND	---	42	0	24 (7)
Th - 232	ND	ND	---	43	3	24 (7)

Note: *ND = No data available

drainage basin (see USGS Water Resources Data, New Mexico, Water Reports NM-75-1 through NM-81-1). The USGS, however, has not performed analyses for specific radionuclides.

Samples of unfiltered runoff from three sites were tested for the isotopes lead-210, polonium-210, radium-226, and thorium-228,-230, and-232. Most of these radionuclides are in the uranium-238 decay series (Figure 4.2). While the observed radionuclide concentrations presented in Table 4.4 are weighted toward the Church Rock district, they are thought to be representative of the entire Grants Mineral Belt. The Church Rock, Ambrosia Lake, and Laguna-Paguate mining districts are very similar in terms of sedimentary geology and landform development. Moreover, sediments collected from Ambrosia Lake and Laguna-Paguate mining districts (Popp and others, 1983) contain concentrations of radium-226 and lead-210 similar to these in the Church Rock district (Weimer, andothers, 1981).

The partitioning of different radionuclides between solid and dissolved phases is significant in runoff. Radium-226 and lead-210, the chief radiological concerns in Grants Mineral Belt runoff, tend to adsorb onto suspend sediments rather than to remain dissolved in runoff (Table 4.5). EID data indicate that 85-to-95 percent of the radum-226 and lead-210 detected in a turbid water sample is bound to the sediment.

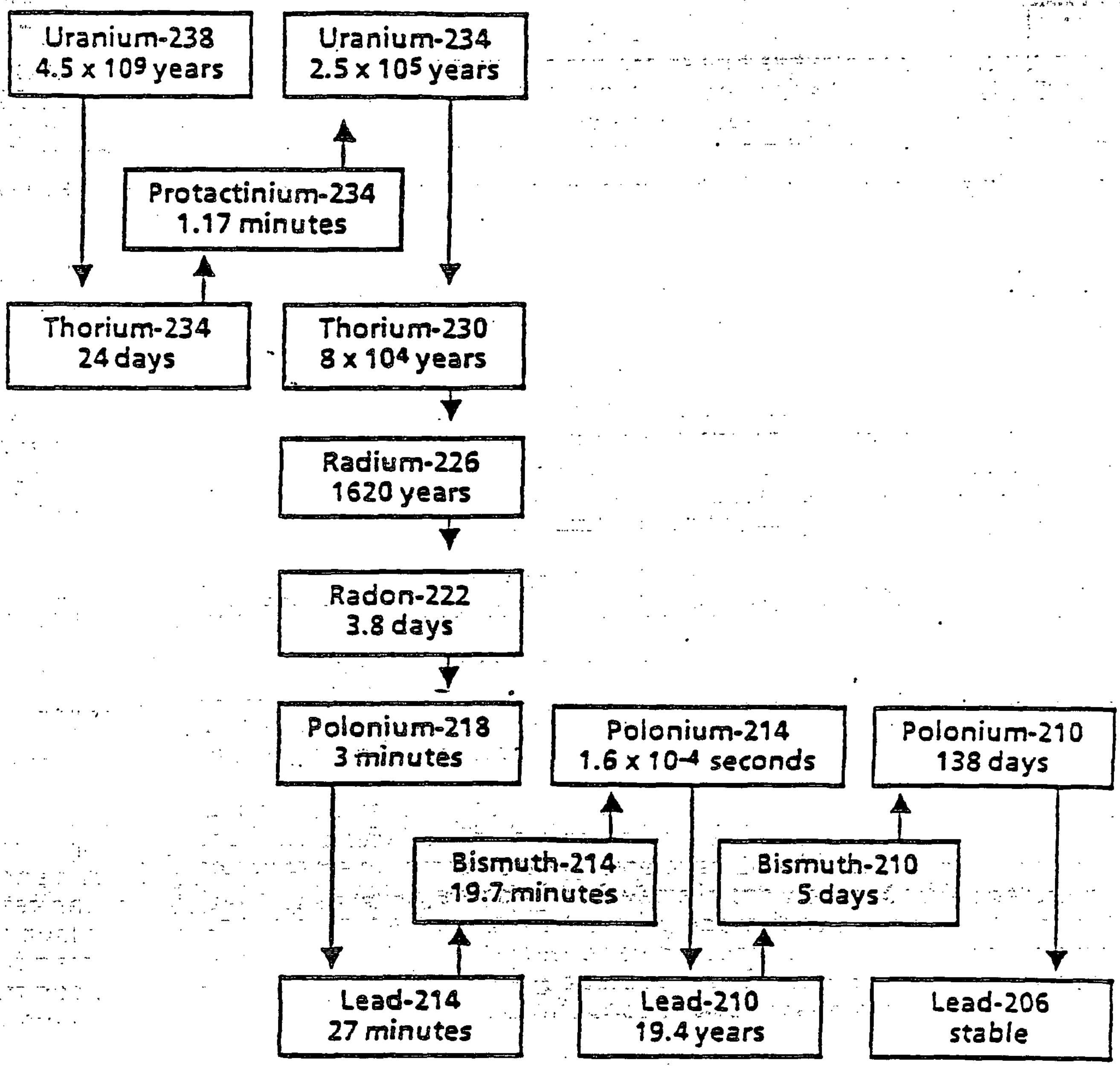


FIGURE 4.2 Principal radionuclides in the uranium-238 decay chain. The half-life of each nuclide is shown. Downward pointing arrows indicate alpha emissions and upward pointing arrows indicate beta and/or gamma emissions.

TABLE 4.5. Partitioning of Radium-226 and Lead-210 between Dissolved and Suspended Fractions of Natural Runoff.

LOCATION	DATE (M-D-Y)	Ra-226 (pCi/l)		Pb-210 (pCi/l)	
		Dissolved	Suspended	Dissolved	Suspended
'uerco River-North Fork BLM cluster	08-04-82	5.8 ± 1.7	41 ± 14	33 ± 5	31 ± 18
	08-24-82	1.3 ± 0.3	2.7 ± 1.1	5 ± 3	6 ± 4
'uerco River-South Fork at Hwy 566 Bridge	08-12-82	0.4 ± 0.1	19 ± 6	2 ± 2	51 ± 17
	08-23-82	1.2 ± 0.4	28 ± 8	6 ± 2	55 ± 21
	08-05-82	3 ± 1	13 ± 15	14 ± 2	21 ± 9
	09-21-82	4 ± 1	19 ± 6	14 ± 2	60 ± 12
a.. mateo Creek at Hwy 53 Bridge	08-03-82	0.7 ± 0.2	22 ± 7	4 ± 2	39 ± 8

V. PRELIMINARY EVALUATION OF THE EFFECTS OF URANIUM MINE WASTE PILES AND OPEN PITS ON NATURAL SURFACE WATER QUALITY

Uranium mine waste piles, both active and abandoned, exert a potentially significant influence on the quality of surface waters in the Grants Mineral Belt. Since the regional onset of uranium mining in the early 1950s, a large area has been explored, prospected, and mined for uranium ore. In a comprehensive survey, Anderson (1980) described 21 abandoned or inactive uranium mine sites in Cibola County and 72 such sites in McKinley County. In addition, Perkins (1979) listed 34 mines that were then active.

In the majority of cases, each mine has associated waste piles. Waste piles may include one or more of the following: barren (non-ore-bearing) overburden, low-grade ore (i.e., are with too low a uranium content to be economically milled), and ore stockpiled for later milling. The EPA (1983) estimated that an average surface mine generates about 6 million metric tons of solid waste per year, while an underground mine generates considerably less - - about 20 thousand metric tons per year. For surface mines waste dumps are larger in proportion to the amount of ore produced, because such dumps are mostly barren overburden. Since the waste varies with respect to ore content, potential impacts on water quality are quite variable. This chapter discusses the impacts of mine waste piles on surface water quality.

The EID investigated the effects of mine waste piles on surface water quality, through runoff sampling and laboratory studies. The sampling program collected water and suspended sediment samples in ephemeral watercourses receiving runoff from mine waste piles. Analysis of runoff samples provided data on concentrations of trace elements and radioactivity in affected arroyos. In conjunction with the runoff sampling, dry samples of mine waste were collected and leached in the laboratory to determine the potential for constituents to leach into surface or ground water.

Open pits created by surface mining have a potential to effect water quality similar to that of waste piles. The exposure of the ore body in open-pit mining subjects it directly to the same runoff factors as waste piles. In addition, as mentioned above, open pits typically have large amounts of waste in the vicinity of the operation. In order to focus on the potential for open pit mining operations to effect water quality, stream sampling was conducted at the largest open pit operation in the Grants Mineral Belt, the Jackpile-Paguate mine. This mining operation is of water quality interest not only because of its size but because of the confluence of two perennial streams within the mining area.

5.1 RESULTS OF RUNOFF SAMPLING

Runoff samples were collected from several sites representing varying degrees of proximity to, and input from, uranium mine waste piles. The data provide information on the water quality impacts of specific piles. The data also help to define generic water quality problems associated with uranium mine waste piles in the region. Throughout the discussion that follows, interpretation of the data is facilitated by frequent reference to natural runoff quality described in Chapter IV. The observations in this section apply directly to the Ambrosia Lake mining district where almost all the samples were collected. Limited sampling results suggest similar sampling results would be obtained in the Church Rock district.

All of the runoff sampling data presented herein reflect instantaneous contaminant concentrations, specific to a particular location and time. Because of the random and short-lived nature of the runoff events, however, the total quantity of mine waste material entering local drainages is unknown. Nonetheless, the mine waste-affected runoff contaminant concentrations exceed natural levels by up to several hundred times, and thus are of concern.

5.1.1. Sediment

Results of runoff sampling suggest that sediment concentrations from uranium mine waste piles in Ambrosia Lake district are comparable to natural sediment concentrations in the district. In 11 samples from drainages with mine waste piles, suspended sediment concentrations ranged from 764 to 75,500 mg/l with a median of about 40,000 mg/l. Three samples from drainages unaffected by waste piles varied from 939 mg/l to 50,000 mg/l with a median of about 32,000 mg/l. The number of samples though is too small to permit definitive statistical analysis.

Cooley (1979) reported that runoff from uranium mine waste piles picks up "clay, silt, and sand, which, depending on the proximity of stream channels, may be transported and deposited downstream." It has been noted that erosion of mine waste piles is accelerated relative to undisturbed soil profiles for a number of reasons, chief of which are lack of topsoil, steep angle of slopes, presence of toxic elements and buildup of salt in the near surface (which inhibit vegetative growth), and poor water retention characteristics (U.S. EPA, 1983).

The U.S. EPA (1983) has stated that most abandoned mines in the region are small surface mines that have little impact on surface waters. Based on recent extensive work by Anderson (1980), we estimate that 10 to 20 percent of all abandoned mines and a few large active mines in the Grants Mineral Belt have waste piles that are directly eroding into local drainage channels.

5.1.2. Trace Elements and Radionuclides

The problem of poor water quality due to high sediment loads is exacerbated when the sediment comes from rock that is geologically enriched in uranium and associated elements, as is the case for mine waste piles. Total contaminant concentrations in drainages affected by uranium mine waste piles are positively correlated with suspended sediment concentrations, just as they are under natural conditions (see Section 4.4) except that waste-affected runoff has proportionally higher contaminant concentrations per quantity of sediment. Therefore, an effective means of evaluating the degree of contamination is comparison of the amount of contaminant per gram of sediment rather than per liter of water. While samples collected at the base of a waste pile reflect uranium mine waste contaminant concentrations, other samples collected far downsteam (up to 5 miles) from any source of contaminants, reflect dilution processes which make them indistinguishable from natural conditions.

Trace Elements

Table 5.1 compares ranges and median of contaminant concentrations found in unfiltered runoff from uranium mine waste piles with those of unfiltered natural runoff. In runoff from these waste piles, uranium and molybdenum maxima exceed maxima in natural runoff by over two orders of magnitude. Maximum arsenic, selenium, and vanadium concentrations exceed maximum natural runoff levels by six to eight times. Other elements (i.e., barium, cadmium, lead, and zinc) are not appreciably above background concentrations. These results indicate that uranium mine waste piles are potential major sources of uranium and molybdenum and perhaps of arsenic,

TABLE 5.1. Total Contaminant Concentrations in Ambrosia Lake Waste Pile Runoff Compared with Natural Runoff. Number of samples in parentheses.

CONSTITUENT	MINE WASTE PILE RUNOFF Range	Median		NATURAL RUNOFF Range	Median	
		(mg/l)				
As	<0.005-1.5	0.21	(15)	0.05 - 0.26	0.13	(6)
Ba	0.18 - 37.5	5.9	(15)	1.4 - 43.5	7.7	(6)
Cd	<0.001-0.02	0.006	(15)	0.003 - 0.05	0.006	(6)
Pb	0.02 - 2.5	0.56	(15)	0.05 - 2.0	0.52	(6)
Mo	<0.001 - 3.2	0.02	(15)	0.005 - <0.01	<0.01	(6)
Se	<0.005 - 0.85	0.03	(15)	<0.005 - 0.15	0.03	(6)
U-natural	0.04 - 62.6	0.58	(15)	0.03 - 0.56	0.10	(6)
V	0.04 - 24.8	1.1	(15)	0.18 - 3.2	0.61	(6)
Zn	<0.05 - 4.4	1.7	(15)	0.38 - 1.7	1.5	(6)
		(pCi/l)				
Gross Alpha	300 - 420,000	10,800	(15)	33 - 2,100	1,200	(5)
Gross Beta	177 - 168,000	6,700	(15)	546 - 2,000	1,060	(5)
Pb - 210	29 - 30,050	1,000	(6)	4 - 720	88	(4)
Ra-226	1 - 34,900	650	(6)	2 - 321	15	(4)

selenium, and vanadium in surface waters. These findings are in general agreement with EPA data (U.S. EPA, 1983).

Radionuclides

Radionuclides in unfiltered waste pile runoff are also elevated with respect to levels in natural runoff (Table 5.1). The data also are graphically depicted in a "box and whisker" plots in Figure 5.1. The lower and upper ends of the box represent the 25th and 75th percentile values, respectively; the vertical line within the box is the median value; and the lower and upper extent of the lines (whiskers) are the minimum and maximum values of the data set (McLeod, Hipel, and Comancho, 1983). Maximum gross alpha particle activity exceeds maximum natural runoff activity by 200 times. Maximum levels of two major alpha emitters, natural uranium and radium-226, exceed natural maximum runoff levels by over 100 times. Gross beta particle activity and its chief contributor, lead-210, are also far in excess of natural runoff levels. Natural runoff and waste pile levels of thorium-230 and polonium-210 cannot be compared because of lack of data.

The Old San Mateo Mine illustrates specific impacts of a large waste pile on nearby surface water drainage system, San Mateo Creek (Figure 5.2). Three nearby stations uncontaminated by mine wastes were used to define trace element and radionuclide levels in natural sediments in the area. In contrast, with natural sediment, the waste materials (sediments from the waste pile) contained elevated levels of gross alpha and gross beta particle activities, radium-226, natural uranium , arsenic, lead, molybdenum, selenium, and vanadium. Contaminant concentrations in stream bottom sediments decreased ultimately to natural levels with distance from the waste pile as other sediments carried along the watercourse become mixed with the mine waste material. Contaminated sediments from Old San Mateo Mine are in evidence at least 550 meters downstream from the mine waste pile. Nonetheless, even natural levels, of trace elements and radionuclides in bottom sediment are relatively high. Bottom sediments can under go a continuing cycle of resuspension in runoff and deposition further downstream.

5.2 MINE WASTE LEACHING TESTS

Thirty seven composite mine waste samples were leached with acetic acid and deionized water in the slightly modified EPA EP toxicity test procedure described in section 3.3.3. Acetic acid (pH <5) simulated the leaching effects of natural rainfall, which is similarily acidic, and deionized water (pH >7.5), the leaching effects of rainfall after contacting the alkaline rich soils common to the Grants Mineral Belt. Leachates were analyzed for arsenic, barium, cadmium, lead, molybdenum, selenium, vanadium, zinc, and gross alpha and gross beta particle activities. By definition, a material exhibits the characteristic of EP toxicity if any of the contaminant concentrations in the leachate exceed federal safe drinking water standards by 100 times or more (40 CFR 261, Appendix II).

Table 5.2 presents average leachate concentrations obtained from tests of mine wastes. None of the samples subjected to this test exhibited the characteristic of EP toxicity. No EP toxicity limits have been established for those constituents found in the highest concentrations, natural uranium and gross alpha activity. The uranium concentrations account for most of the alpha activity (for natural uranium, 1.0 mg/l is equivalent to 677 pCi/l of alpha activity, at secular equilibrium). These results suggest that in a neutral or slightly acidic environment, contaminants in uranium mine wastes have a relatively low potential for leaching or for significantly degrading ground water quality.

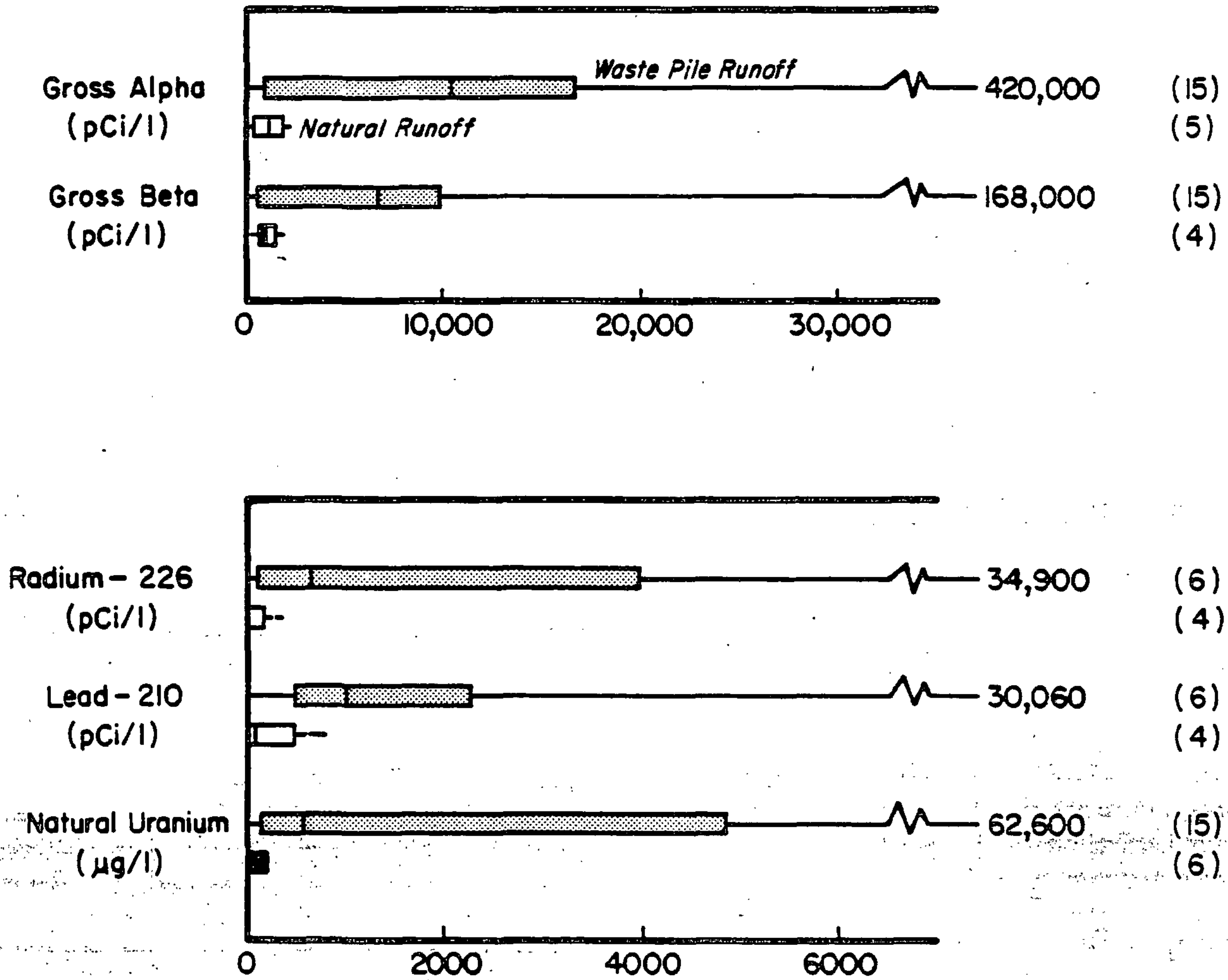


FIGURE 5.1 Total radioactivity and uranium concentrations in uranium mine spoils piles runoff, Grants Mineral Belt.

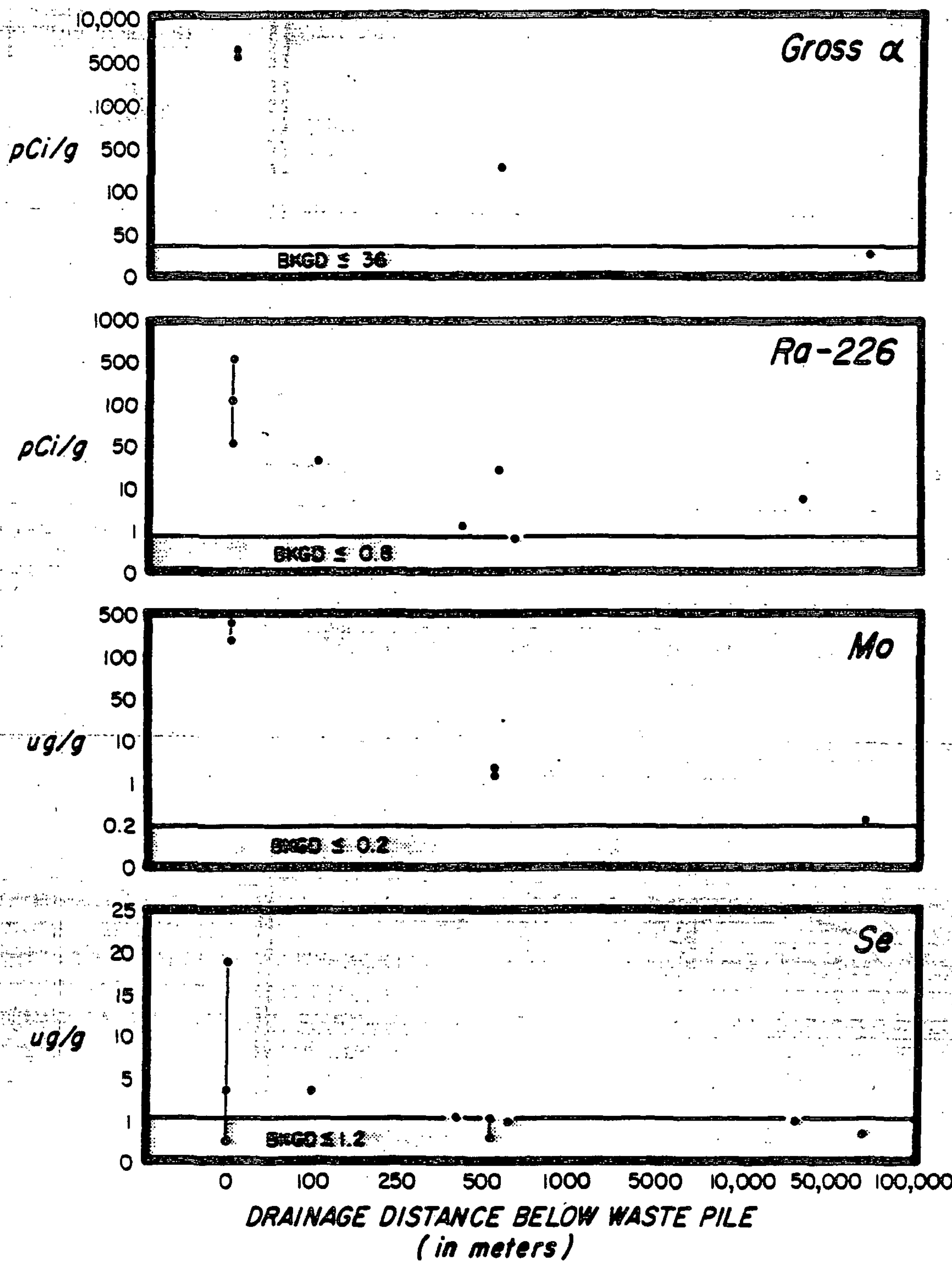


FIGURE 5.2 Persistence/attenuation of selected contaminants in sediments within the drainage system below the Old San Mateo Mine waste pile. Each analysis is represented by dot; some stations have multiple analyses. Three nearby stations were used to define natural background levels.

TABLE 5.2 Results of Mine Waste Leaching Tests (EP Toxicity Water Extract)

AVERAGE CONCENTRATIONS (mg/l)

MINE	As	Ba	Cd	Pb	Mo	Se	U-natural	V	Zn	Gross Alpha*	Gro Bet
UNC-NE Church Rock (4 composite samples)	.005	.145	<.001	<.005	<.01	.026	.910	.029	<.05	706	250
KM-1 Church Rock (4 composite samples)	.006	.142	<.001	<.005	.132	.097	1.09	.015	<.05	663	282
Hyde** (6 composite samples)	<.005	<.10	.001	.006	<.01	.015	.231	.01	.139	240	143
Vallejo (7 composite samples)	.006	.102	<.001	.005	<.01	.006	.136	.011	<.05	93	28
Poison Canyon (8 composite samples)	.010	.176	.01	<.005	.021	.007	.056	.080	<.05	51	7
Old San Mateo (8 composite samples)	.029	.162	.003	<.005	.955	.069	1.42	.011	<.05	1030	164
RCRA ALLOWABLE LIMITS	5	100	1.0	5	NL***	NL***	NL***	NL***	NL***	NL***	NL*

*Concentration in pCi/l
** Acetic Acid Extract
*** No established limit

5.3 PERENNIAL FLOW THROUGH AN OPEN PIT MINE

The water quality impacts of an open pit uranium mine on perennial streams were studied at the Jackpile-Paguate mine on the Pueblo of Laguna east of Grants. This mine, covering more than 2700 acres of disturbed land, is by far the largest open pit uranium mine in the Grants Mineral Belt. In its twenty-five years of operation, this mine has excavated almost 200 million tons of overburden and mine waste. This is stored in 28 dump sites spread over more than 1100 acres. The pit itself encompasses about 1,000 acres and, in places, approaches 400 feet in depth (U.S. Department of the Interior, 1980).

Two of the several natural perennial streams which descend the northeast flank of Mt. Taylor, the Rio Paguate and the Rio Moquino, converge within the mine; the Rio Paguate continues through the open pit area and eventually flows into the Paguate Reservoir. Water released from the reservoir flows into the Rio San Jose near the town of Laguna. Figure 5.3 shows these features.

A reconnaissance of the Jackpile-Paguate mine area performed by Cooley (1979) provided visual evidence of uranium mine waste piles affecting surface waters. He reported that mine waste had been dumped along the margins of Rio Paguate and that:

> During large flows the river cuts laterally into debris piles. Corrosion of the unconsolidated debris adds considerable bedload and suspended sediment to the river.

Data presented in a recent study by Popp and others (1983) demonstrate that mining activities at the Jackpile-Paguate mine have caused a significant increase in the naturally occurring radioactivity in that drainage system. Detailed chemical and radiological analyses were performed on the sediment which has accumulated in Paguate Reservoir downstream from mine. The data clearly show elevated levels of uranium-238 decay products in sediments da... after the mid-1950s. Additionally, lead-210 concentrations in sediments increased from pre-mining levels of approximately 2 pCi/g to average post-mining concentrations of approximately 10 pCi/g.

The perennial waters that traverse the mine area have been studied by the EID for uranium industry impacts since 1978. Surface water samples were collected quarterly at two background sites (Rio Paguate and Rio Moquino upstream from the mine) and one impacted site (Rio Paguate below the mine). Figure 5.3 shows the sampling locations.

As a result of the typically low sediment concentrations in the Rio Paguate, the concentrations of suspended (total minus dissolved) radioactive substances are usually negligible relative to those of the dissolved fraction (Table 5.3). During periods of runoff, however, total radioactivity would be expected to increase because of greater sediment concentrations.

Water quality data from the three sites sampled by the EID demonstrate that the dissolved concentrations of several constituents increase in the streams flowing through the mine area. Table 5.4 shows that average concentrations of gross alpha emitters, radium-226, arsenic, barium, cadmium, lead, molybdenum, selenium, natural uranium, vanadium, and zinc are quite low in the waters above the mine. In fact, both background streams, dissolved concentrations of arsenic, cadmium, lead, molybdenum, selenium, natural uranium, vanadium, and zinc were below detection limits for at least 67 percent of the samples. Among the trace elements, only barium was detected in more than half of the samples in the two streams.

By the time the Rio Paguate exits the Jackpile-Paguate mine, several dissolved constituents ... elevated above background levels (Table 5.4). Radioactive parameters experience the largest dissolved concentrations increases; gross alpha particle activity, radium-226, and natural

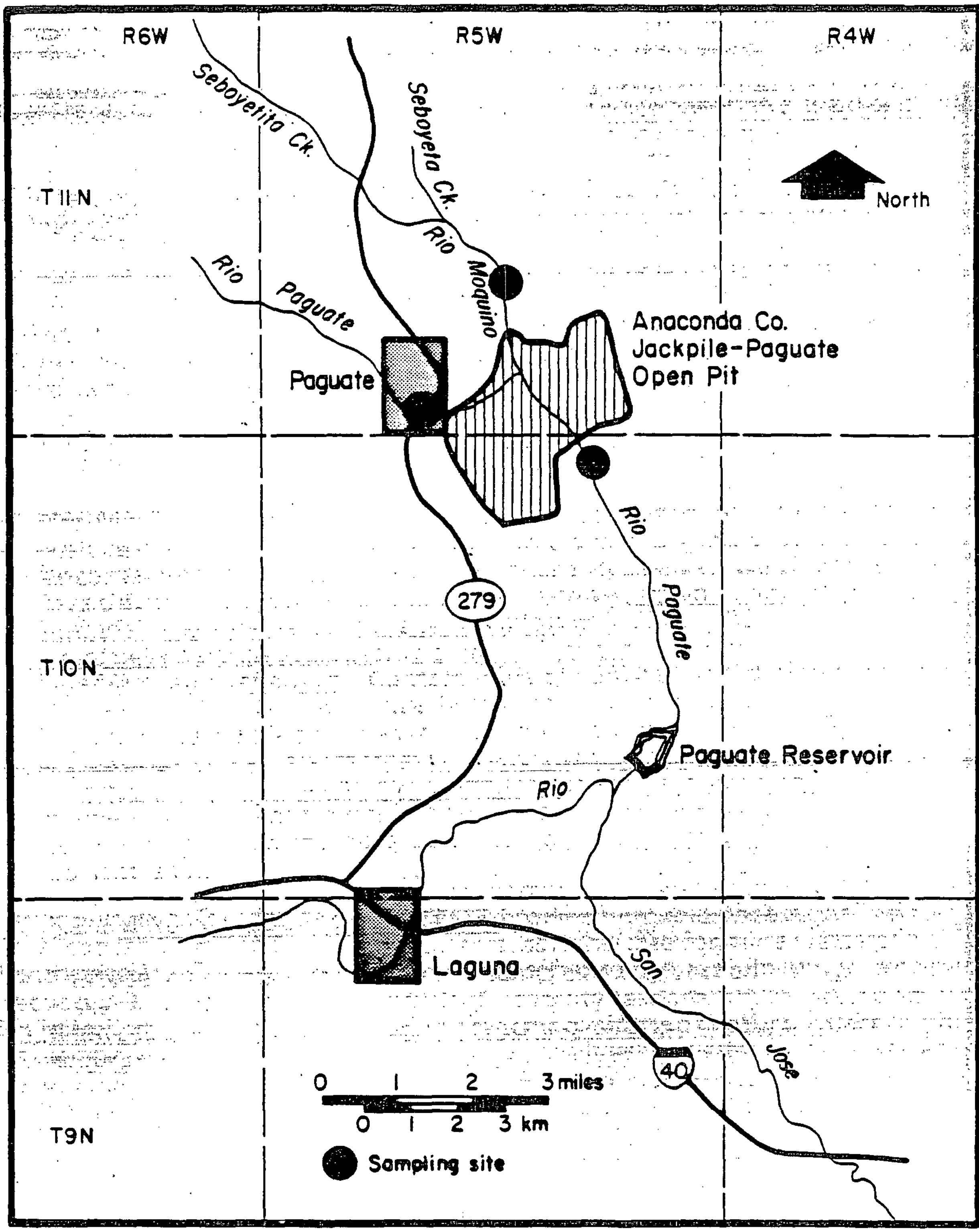


FIGURE 5.3 Major features of the Laguna-Paguate mining district

TABLE 5.3. Radioactivity and Suspended Solids Concentrations in Rio Paguate below the Jackpile - Paguate Mine.

SAMPLE DATE	GROSS ALPHA ACTIVITY (pCi/l)		RADIUM-226 (pCi/l)		TOTAL SUSPENDED SOLIDS (mg/l)
	Dissolved	Total	Dissolved	Total	
6-09-80	78 ± 6*	79 ± 6	3.6 ± 0.1	4.1 ± 0.2	36
12-08-80	71 ± 10	68 ± 10	1.0 ± 0.03	1.1 ± 0.1	27
6-24-81	155 ± 22	153 ± 15	1.4 ± 0.04	1.7 ± 0.1	5

* Picocuries per liter ± one sigma counting error.

TABLE 5.4. Average Surface Water Quality Above and Below the Jackpile-Paguate Mine. Averages based on a minimum of 7 samples.

DISSOLVED CONSTITUENT (ug/l unless noted)	RIO MOQUINO ABOVE JACKPILE MINE	RIO PAGUATE ABOVE JACKPILE MINE	RIO PAGUATE BELOW JACKPILE MINE
TDS (mg/l)	1540	525	1705
SO_4 (mg/l)	825	155	960
pH (s.u.)	8.2	8.0	8.2
As	<5	6	6
Ba	145	130	145
Cd	2	<1	2
Pb	<5	<5	<5
Mo	7	7	7
Se	5	5	6
U-natural	6	6	120
V	10	9	10
Zn	<250	<250	<250
Gross alpha (pCi/l)	3.7	1.0	79
Gross beta (pCi/l)	9.6	4.2	48
Ra-226 (pCi/l)	0.48	0.19	3.7

* For locations, are given on Figure 5.3

uranium all increase by factors of 10 or more. Aside from uranium, there are no statistically significant increases in dissolved trace elements concentrations.

VI. HYDROLOGIC EFFECTS OF MINE DEWATERING EFFLUENTS

Disposal of uranium mine dewatering effluents in the normally dry arroyos of the Grants Mineral Belt has had a significant impact on regional surface waters and ground waters. Where dewatering occurs, ephemeral streams are transformed into perennial streams. The artifically supplied perennial streams have dramatically increased the volume of water that recharges underlying alluvial aquifers. The added recharge has raised water tables and increased the amount of ground water that can be easily obtained from shallow wells. As a result, more near-surface ground waters and surface waters are available.

6.1. HISTORY

The history of uranium mine dewatering has been summarized by Perkins and Goad (1980). In general, dewatering has been performed continuously in the region since at least 1956. The Church Rock and Ambrosia Lake mining districts have witnessed the largest volume of mine dewatering. Water production from mines in the Ambrosia Lake district has been continuous since 1956, with peak production in the early 1960s. Significant dewatering in the Church Rock area began in 1967 and peaked about 1980. Decline of the industry since 1980 has caused several mines to close and the flow of dewatering effluents to diminish in both the Ambrosia Lake and Church Rock districts. Some mines which are not extracting ore, however, have been placed on "stand-by status" and continue dewatering operations. Figure 6.1 illustrates the history of minewater production in the Grants Mineral Belt through 1982.

6.2. HYDROLOGIC IMPACTS ON REGIONAL SURFACE WATERS

6.2.1. General Characteristics of Flow Before and During Mine Dewatering

Prior to dewatering of underground uranium mines in the 1950s and 1960s, the regional drainages were ephemeral. These streams experienced an wide range of discharges, from zero flow to large flash floods (e.g., Busby, 1979). Maximum discharges of flash floods often reach several thousand cubic feet per second (cfs) (Thomas and Dunne, 1981). The only significant perennial waters in the region are a few small springs along the Puerco River, and perennial streams draining the north and east flanks of Mt. Taylor.

Discharges of uranium mine dewatering effluents have transformed several ephemeral streams to perennial streams flowing for many miles. Minewaters have provided perennial baseflow for Pipeline Arroyo and the Puerco River in the Church Rock mining district, and Arroyo del Puerto and San Mateo Creek in the Ambrosia Lake mining district. Other newly created perennial streams occur in other regional mining districts not covered by this report. Table 6.1 presents approximate average distances that perennial flow conditions are sustained by various mine discharges during 1979-1981. The greater distances occur along river reaches where stream bottom leakage rates are relatively low.

Before mine dewatering, flow in the Puerco River, for example, was distinctly seasonal (Figure 6.2). One season of flow was late winter (February through April) a time of gentle frontal precipitation and melting snow. May and June were months of little or no precipitation and low stream flow in the Puerco River. The second season of flow was middle-to-late summer (July through October). Summers in the region are usually characterized by frequent, intense, and isolated thunderstorms that can produce large

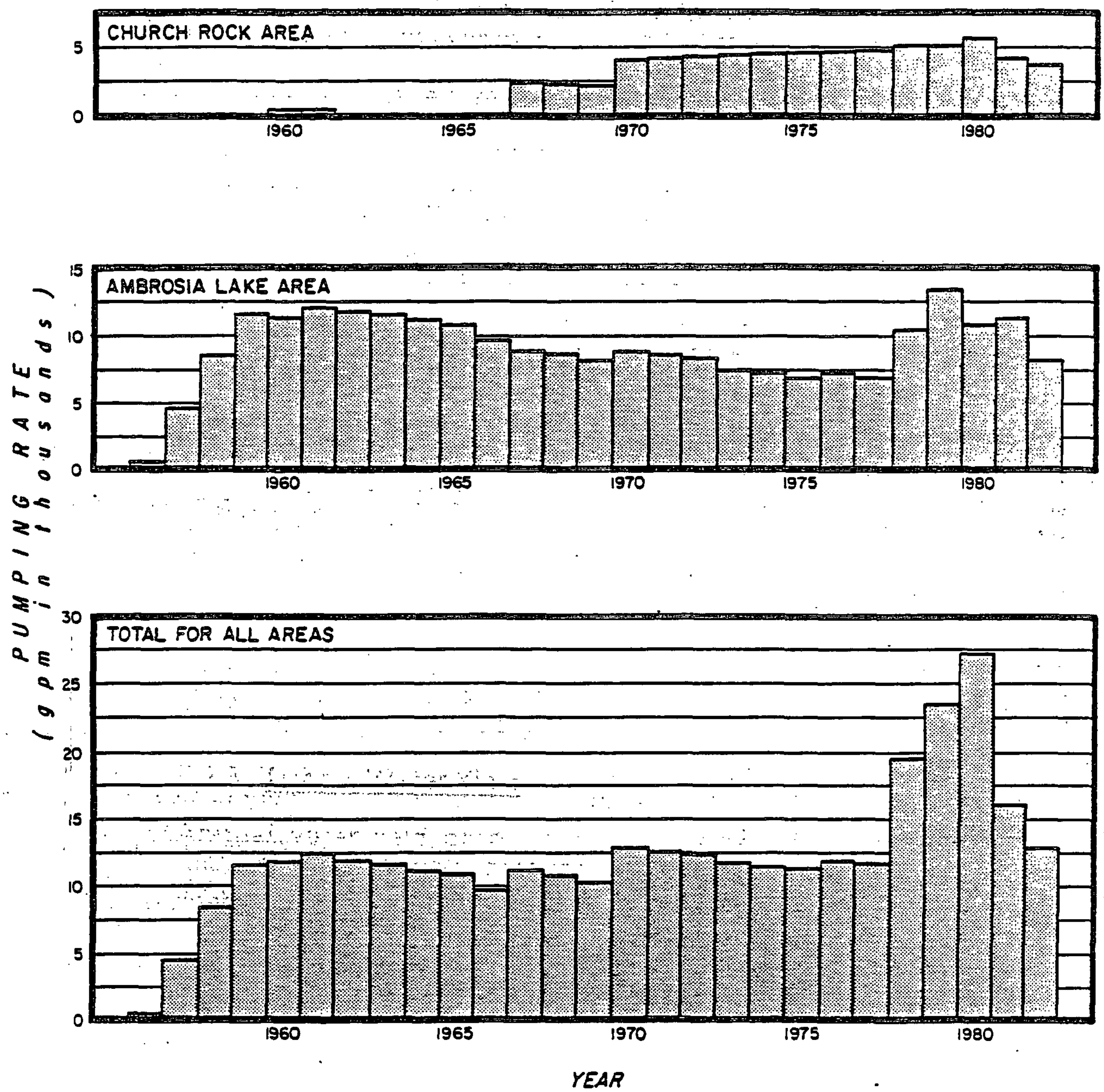


FIGURE 6.1 Water production by uranium mines, Grants Mineral Belt.

TABLE 6.1 Approximate Average Distances of Constant Flow below Mine Discharges, 1979-1981. Location of mining districts shown on Figure 2.1.

DRAINAGE CHANNEL	VOLUME OF DISCHARGE (gallons per minute)	APPROXIMATE DISTANCE OF FLOW* (miles)
	Church Rock Mining District	
Puerco River	5000	50
	Ambrosia Lake Mining District	
Arroyo del Puerto	2300	5
San Mateo Creek	1500	3
	Mt. Taylor Mining District	
San Lucas/Arroyo Chico	4000	40
	Crownpoint Mining District	
Kim-me-ni-oli Wash	3400	20
	Marquez Mining Area	
Rio Marquez	1000	15
Rio Salado	1000	10

*Distances are based on the authors' observations, review of EID files, and U.S. Geological Survey annual water data reports.

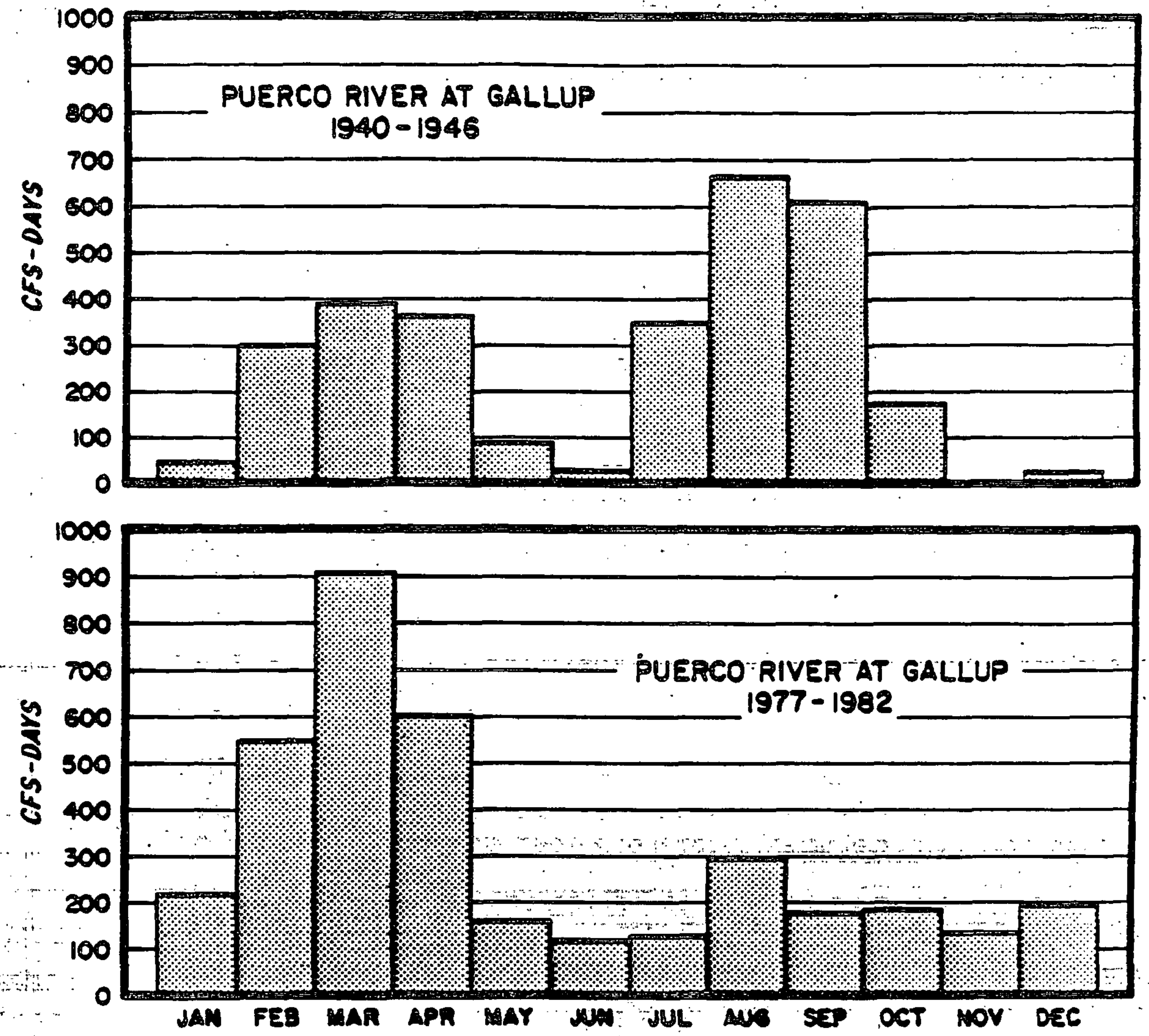


FIGURE 6.2 Monthly flow in the Puerco River at Gallup before mine-dewatering and with flow augmented by mine dewatering

flash floods. Autumn months of November through January were once again dry, in terms of both precipitation and stream flow.

With ongoing mine dewatering, flow in the Puerco River become continuous. Figure 6.2 shows that climatic dry seasons (May through June and November through January) are no longer times of no flow in the Puerco. Whereas during these months in the 1940s the Puerco River was often without flow, between 1977 and 1982 the river was never dry and flow at all months averaged at least 120 cfs-days.

Figure 6.2 depicts augmented late winter stream flows, but few high flows in middle-to-late summer. The dearth of summer high flows in recent years reflects the failure of significant summer thunderstorms to materialize over the basin from 1978 to 1981. These storms returned in 1982 and 1983. A longer period of record would probably show the continued presence of the two high flow seasons that typified the pre-mining era.

6.2.2. Characteristics of Low Flows

Flow duration curves constructed for daily discharges in the Puerco River for the periods 1940 to 1946 and 1977 to 1982 further demonstrate the change in low flow conditions attributable to the continuous discharges of uranium mine dewatering effluents (Figure 6.3). Prior to mine dewatering, streamflow in the Puerco River at Gallup was greater than 1 cfs only 20 percent of the time (Curve A). In fact, the stream was normally dry. Since mine dewatering, however, the Puerco River has been perennial. The median discharge (that flow that has been equalled or exceeded 50 percent of the time) is now about 5 cfs at Gallup (Curve B) under the new artificial flow regime.

The Pipeline Arroyo/Puerco River system is now perennial from the Church Rock mines to as far as Arizona, a distance of about 50 river miles. Eventually, unless naturally augmented, all surface flow is lost to infiltration, evaporation, and transpiration. Comparison of median flow at Church Rock (Curve C) and Gallup (Curve B) suggests that about 2.5 cfs of flow is lost between these two gages. As the Puerco River continues into Arizona, its flow eventually becomes intermittent and then ephemeral.

6.2.3. Annual Water Yield

Annual water yield, or the yearly volume of surface flow, in the Puerco River at Gallup has increased substantially because of mine dewatering (Table 6.2). The logarithmic mean annual water yield at Gallup was about 1900 cfs-days in the 1940s. This is assumed to be representative of pre-mining conditions The years 1977-1982 exhibit a logarithmic mean annual water yield of about 3400 cfs-days. These years, therefore, exhibit a 78 percent increase in water yield over pre-mining conditions.

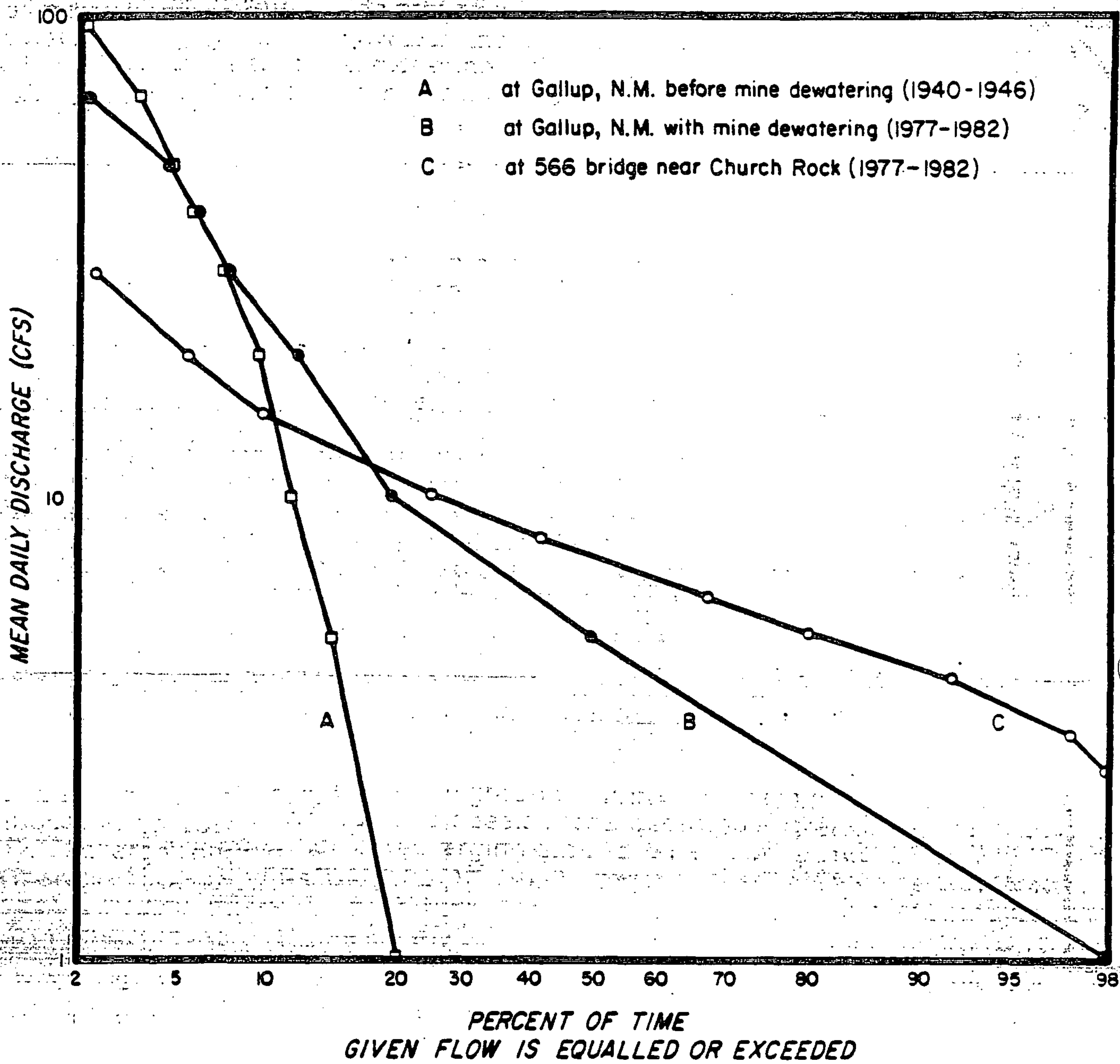


FIGURE 6.3 Flow duration curves for the Puerco River before mine dewatering and with mine dewatering

TABLE 6.2 Annual discharge for the Puerco River at Gallup before Mine Dewatering and with Flow Augmented by Mine Dewatering in cfs-days. Source: USGS.

BEFORE MINE DEWATERING		WITH MINE DEWATERING	
Water Year	Annual Discharge	Water Year	Annual Discharge
1940	7,283	1978	1,502
1941	1,459	1979	5,656
1942	2,893	1980	5,463
1943	741	1981	2,702
1944	3,264	1982	3,446
1945	645		
Log Mean	1,906		3,366

Although no stream flow data exist for San Mateo Creek before mine dewatering, flow records for 1977 through 1982 include periods both of active discharge to San Mateo Creek and of no discharge. Dewatering was ongoing in 1977, when flow measurement in San Mateo Creek began. At that time, about 2900 gallons per minute of dewatering effluents were released to San Mateo Creek (Perkins and Goad, 1980). Beginning in spring 1978, however, virtually all effluents were diverted for irrigation and to an adjacent drainage basin and did not reach San Mateo Creek. The impact of this diversion on flow in the stream can be seen in Figure 6.4. It is clear that the dewatering effluents maintained a small perennial stream at the gage site. Without the minewaters, flow in San Mateo Creek at the gage site is much reduced and ephemeral.

6.3 HYDROLOGIC IMPACTS ON REGIONAL GROUND WATERS

Streams created by the discharge of dewatering effluents are, with the possible exception of a few reaches, losing flow to the subsurface. While some surface flow is evaporated or transpired, a large volume infiltrates into the arroyo beds, and thereby recharges the shallow alluvial aquifers of the Puerco River, Arroyo del Puerto, and San Mateo Creek, among others.

Rates of infiltration were probably greater at the onset of mine dewatering than they are today because of a gradual "filling" of available storage in the alluvium. Infiltration rates along Arroyo del Puerto and San Mateo Creek are rapid Relative to the Puerco River, due to an abundance of sandy material in San Mateo Creek and because of influences of underlying dewatered bedrock aquifers. Gaging data indicate average stream bed losses along the San Mateo Creek of approximately 0.72 m^3/min/km, as compared with bed losses along the Puerco River of about 0.24 m^3/min/km (EPA 1983).

Infiltration has been estimated to range from at least 90 percent to perhaps 99 percent of mine discharge (EPA, 1983). A review of flow records from the Church Rock mining district showed seepage losses of 7.5 m^3/min in October 1975, and 7.25 m^3/min in July

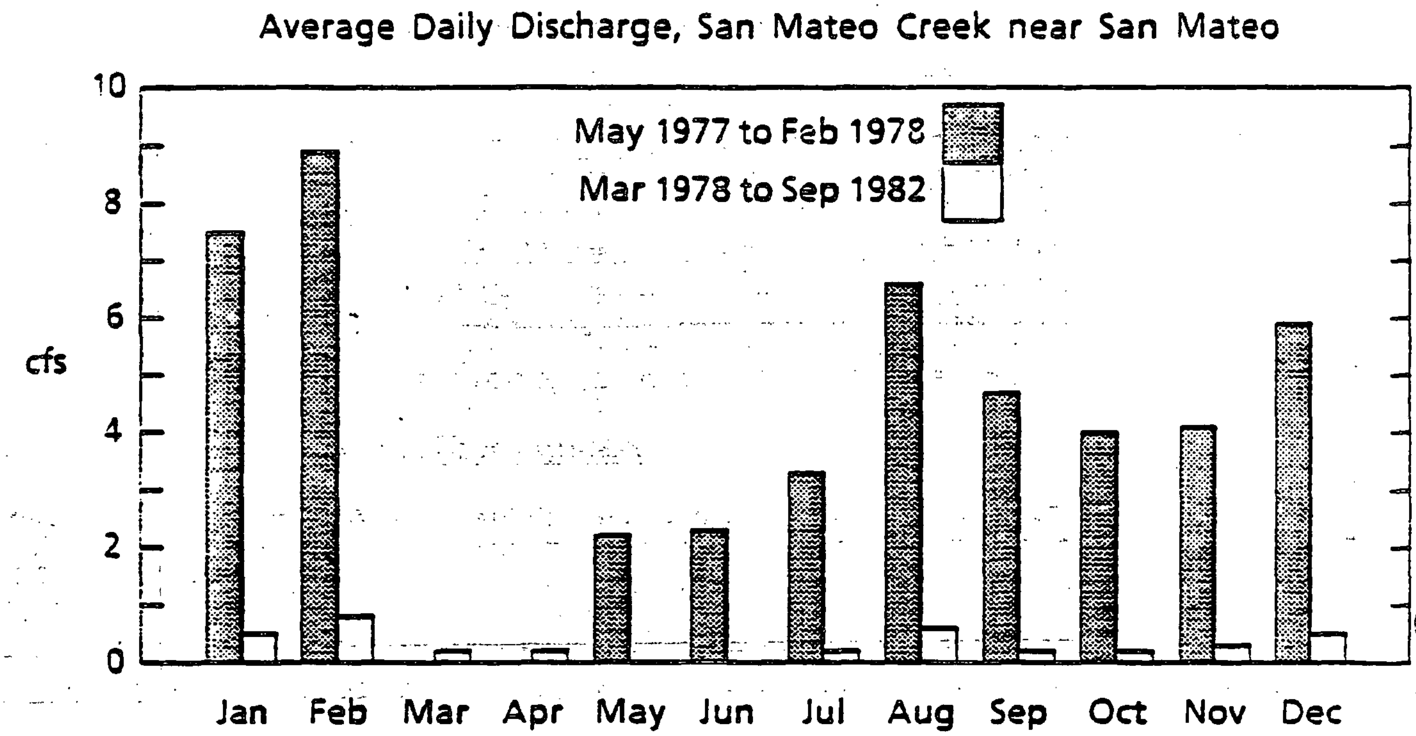


FIGURE 6.4 Average daily discharge for San Mateo Creek near San Mateo before and after diversion of mine dewatering effluents

1977 and May 1978. In the Ambrosia Lake mining district, infiltration was calculated at 7.54 m^3/min.

The overall hydrologic impact of mine dewatering on bedrock aquifers has been a region-wide acceleration of drawdown in these aquifers. In a limited number of stream reaches, however, the hydraulic connection between the alluvial aquifer and underlying bedrock allows some recharge of deeper sandstone aquifers (Lyford, 1979), i.e., water pumped from the mines is returned to the sandstone aquifers via recharge.

6.3.1. Hydraulic Connection Between Surface Waters and Shallow Ground Waters

While recharge generally is a continuous process along the minewater-dominated streams, it is intermittent under natural conditions. The intermittency of natural recharge largely minimizes the potential for dilution of contaminant concentrations in minewater affected ground water. Under natural conditions, ground-water levels most clearly demonstrate a response to surface flows in late winter and early spring. This period, usually February to April, is one of warming weather, melting snows, and gentle frontal rains. Stream flows during this period are usually increased above low winter flows. Moreover, these higher flows tend to be of long duration, often lasting several weeks. These flows, even though not of the magnitude of summer flash floods, provide a prolonged period of heightened flows that enhance infiltration to the underlying alluvium.

Figures 6.5 and 6.6 illustrate the intermittency of recharge from natural runoff along a reach of San Mateo Creek. In March and early April of 1980, a time when mine dewatering discharges to the channel were insignificant, occasional flows of less than 1 cfs, recharged the alluvium and caused the water table to rise slowly (Figure 6.5). In late April, however, stream flow increased to as great as 3 cfs. The period of increased flow was almost two weeks long, ending on April 29, 1980. Ground water response to the elevated flows was rapid: the water table began to rise within one week and peaked in mid-May, more than one foot higher than in mid-April.

In general, shallow ground water levels are much less responsive to summer flash floods. Such floods exhibit peak discharges often as great as several thousand cfs, but their potential for recharging ground water is offset by their brevity. The large volumes of thunderstorm runoff usually traverse miles of arroyo bed in a matter of hours. While most of the water eventually does infiltrate, it may penetrate only a short distance into the alluvium. Very little water reaches the water table; most is ultimately evaporated or transpired.

The relationship between surface flows and ground water levels in summer is illustrated in Figure 6.6. After receiving significant recharge in late April 1980, the alluvial aquifer underlying San Mateo Creek experienced a declining water table through the summer. Brief runoff events generated by thunderstorms during August had an insignificant impact on the declining levels. Even the high flows of September, which had an instantaneous peak discharge of 16 cfs (U.S. Geological Survey, 1980), failed to percolate to the underlying alluvial aquifer in noticeable quantities. While summer flash floods resulting from thunderstorms are probably too short-lived to significantly recharge alluvial aquifers, San Mateo Creek and other alluvial systems in the region do demonstrate a close hydraulic connection that is most responsive to late winter and spring stream flow.

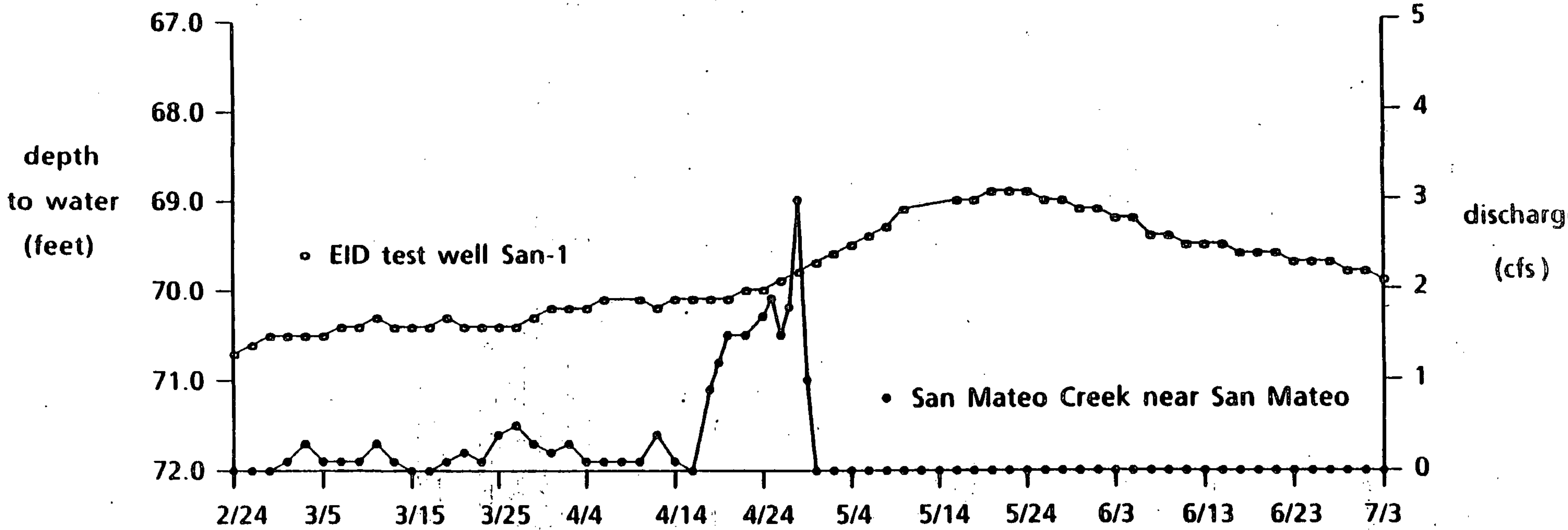


FIGURE 6.5 Streamflow and ground-water levels at the San Mateo Creek near San Mateo gaging site, February-July, 1980

6.3.2. Storage of Water in Alluvial Aquifers

Much of the water resulting from the dewatering of uranium mines has gone into storage in valley fill aquifers. Indeed, in the Ambrosia Lake district, water tables in affected aquifers may have risen as much as 50 feet between the onset of mine dewatering in the 1950s and the late 1970s (Kerr McGee Nuclear Corp., 1981).

Minewater production has been greatly reduced in the Ambrosia Lake district in recent years. Major minewater producers of the 1960s and 1970s (Kerr-McGee and Ranchers Exploration, for example) have drastically curtailed or completely ceased their discharges of dewatering effluents into San Mateo Creek and Arroyo del Puerto. Cessation of minewater discharges in this drainage basin has resulted in a diminished volume of water recharging the alluvium. Water levels in well OTE-1, below the confluence of Arroyo del Puerto and San Mateo Creek, showed continuous decline from March 1978 to March 1982 (Figure 6.7). During this time the water table at this site fell a total of eight feet, a rate of 2.0 feet per year. Alluvial water levels subsequent to the cessation of mine dewatering now appear to be returning to their natural conditions.

6.3.3. Bedrock Aquifers

For the most part, ground water recharge by dewatering effluents is limited to the shallow alluvial aquifers. There are a few stream reaches, however, in which the saturated valley fill overlies permeable bedrock with a downward hydraulic gradient. These places are recharge zones for northward dipping bedrock aquifers such as the Morrison Formation. At these localities, dewatering effluents are drawn by the downward gradients into the alluvium and eventually into the underlying sandstone.

Recharge of bedrock units by minewaters is seen to occur at varying degrees in virtually all of the mining districts where minewaters flow across bedrock subcrops or outcrops (Figure 6.8). This recharge mechanism has been noted in the Church Rock area by Raymondi and Conrad (1983) and Gallaher and Cary (1986); at Ambrosia Lake by Kaufmann, Eadie, and Russell (1976), Brod and Stone (1981), and Stephens (1983); and near San Mateo by Gulf Minerals Resource Co. (1979).

The total volume of minewater which enters the bedrock units probably represents only a small fraction of that which infiltrates to the shallow alluvial aquifers. Nevertheless, in the Ambrosia Lake district, effluents discharged to the Arroyo del Puerto and to the San Mateo Creek constitute a significant proportion of the locally derived recharge in the Dakota and Morrison Formations.

Recharge of the Morrison Formation by minewaters within the drainages is encouraged by regional dewatering of the unit by the mines. Despite some return flow of formation waters, local water level declines in excess of 500 feet have resulted from the dewatering (Lyford and others, 1980).

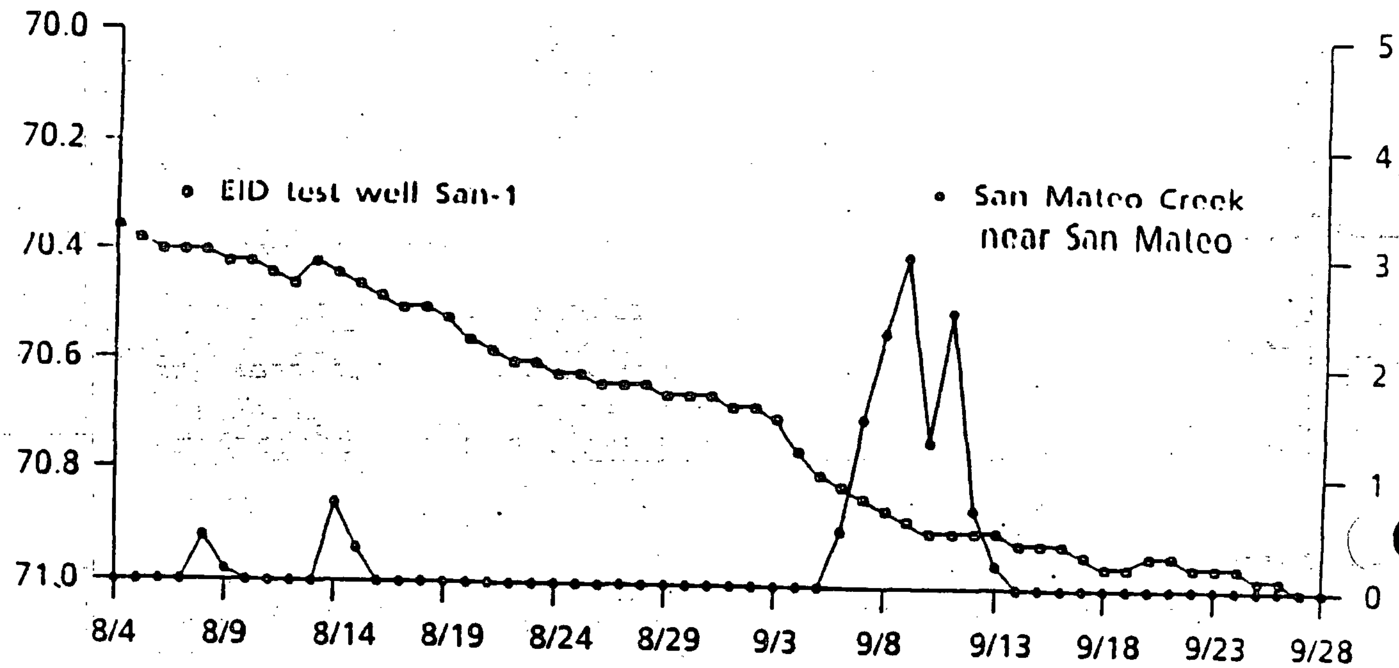


FIGURE 6.6 Streamflow and ground-water levels at the San Mateo Creek near San Mateo gaging site, August-September, 1980

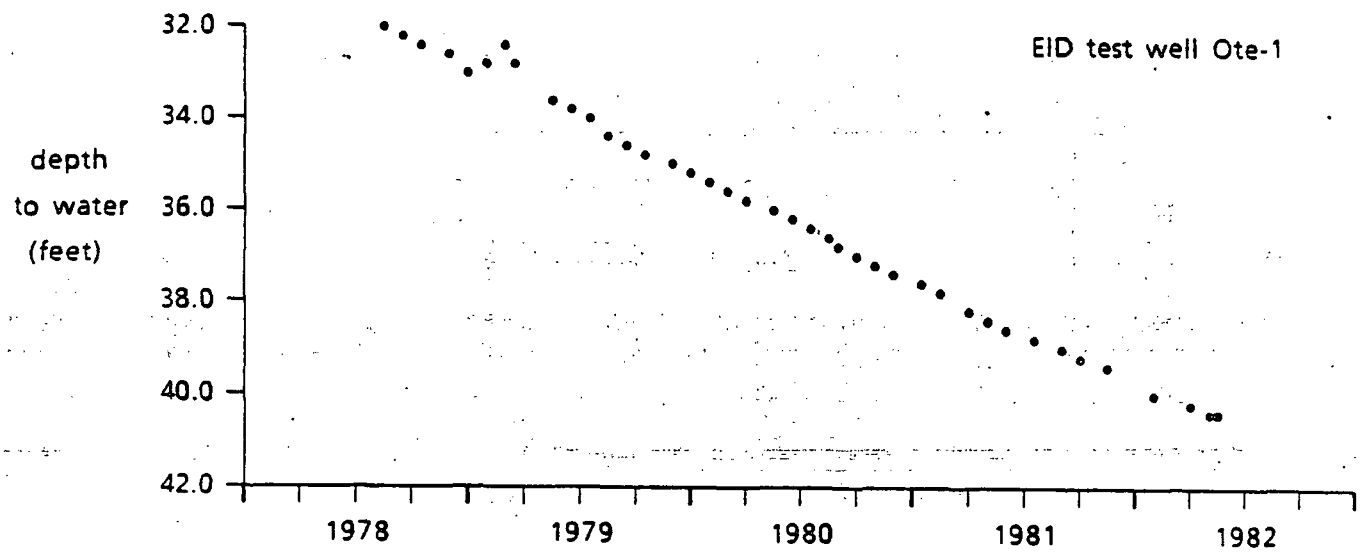


FIGURE 6.7 Ground water levels at EID test well OTE-1, 1978-1982

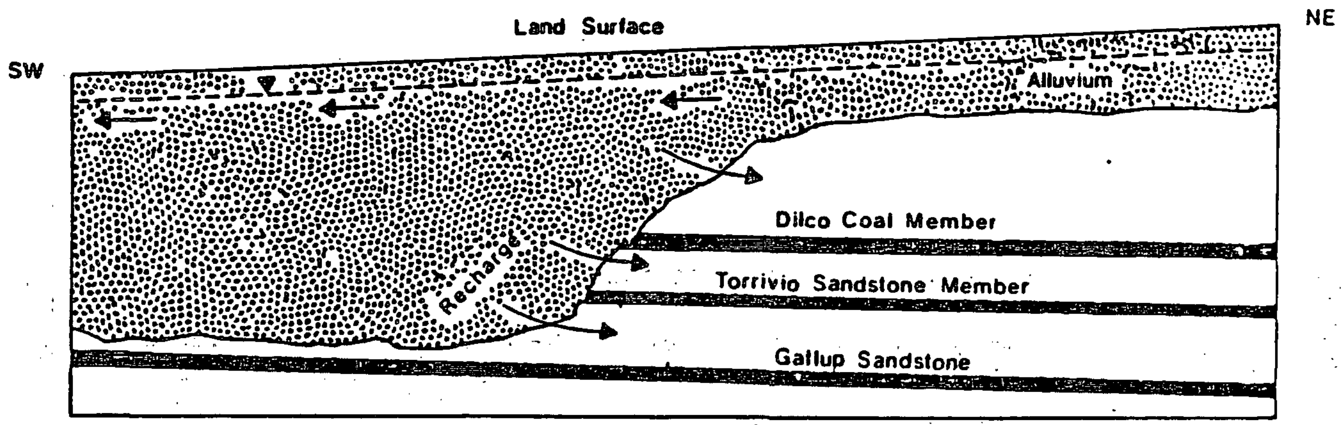


FIGURE 6.8 Conceptual diagram illustrating alluvial aquifer ground water recharge to underlying bedrock aquifers (after Raymondi and Conrad, 1983).

VII. IMPACTS OF MINE DEWATERING EFFLUENTS ON SURFACE WATER QUALITY

This chapter documents the chemical influences that mine dewatering effluents have had on the natural surface water environment. The chemical quality of treated minewaters differs in several important ways from the chemical quality of receiving surface waters. Dewatering effluents are most often different with respect to amounts of total dissolved solids and suspended sediments, general ionic composition, and concentrations of trace elements and radionuclides associated with uranium ore deposits.

In most affected drainages, dewatering effluents constitute a substantial portion of the total amount of water. Therefore, water quality characteristics of receiving streams frequently have been altered to reflect the chemical character of minewater rather than their natural quality. A comparison of the quality of effluent streams with regulatory standards is presented in Chapter IX.

7.1 RAW MINEWATERS

A review of the literature indicates that various trace elements, radionuclides, and dissolved salts can be found in raw (i.e. untreated) uranium mine dewatering effluents (Clark, 1974; U.S. EPA, 1975; Perkins and Goad, 1980). In raw minewaters in the Grants Mineral Belt (Table 7.1), the constituents present at elevated concentrations are 1) gross alpha and beta particle activities and the radionuclides radium-226, lead-210, and natural uranium; 2) the trace elements molybdenum and selenium and; 3) dissolved solids, particularly sulfate. Occasionally, barium, arsenic, and vanadium are detected at elevated concentrations in raw minewaters.

It was only in the past decade that mine dewatering effluents received any noteworthy treatment before their release into Grants Mineral Belt drainages. Until that time thousands of gallons per minute of raw minewaters were discharged to Arroyo del Puerto and the Puerco River. As suggested by Table 7.1, these waters often contained high levels of uranium, radium-226, and gross alpha particle activity.

7.2 TREATED MINEWATERS

Beginning in the mid-1970's, the quality of minewaters discharged to watercourses began to improve, because many mine operators adopted minewater treatment systems. The basic treatment strategy is outlined by Perkins and Goad (1980):

> Once the water pumped from a mine reaches the surface it usually goes through one or more mine water settling ponds. At most facilities a flocculant is added to promote settling. Barium chloride is usually added to the liquid after it has gone through one or more suspended solids settling ponds. Further settling and precipitation of radium as a barium sulfate salt then occurs as the liquid moves through additional settling pond(s). Where uranium levels are high enough to justify it, the liquid is usually run through an ion exchange (IX) plant for recovery of uranium contained in the mine water. The IX plant may either precede or follow barium chloride treatment.

As a result of treatment, minewater concentrations of radium-226, lead-210, polonium-210, natural uranium, and gross alpha activity are considerably reduced. Concentrations of most other minewater constituents, though, are not greatly influenced by these treatments. As collected by EID personnel.

CONSTITUENT	AMBROSIA LAKE MINING DISTRICT				CHURCH ROCK MINING DISTRICT			
	MAX.	MIN.	MEDIAN	SAMPLE SIZE	MAX.	MIN.	MEDIAN	SAMPLE SIZE
	(mg/l)							
TDS	1,800	740	1,235	10	960	434	525	9
SO_4	1,030	310	715	10	458	126	156	9
	(mg/l)							
As	0.08	0.008	0.021	8	0.40	0.005	0.008	6
Mo	5.30	<0.01	1.19	10	0.791	0.008	0.030	6
Se	1.22	0.014	0.075	10	0.071	0.011		6
U-natural	20.0	1.56	3.82	10	27.30	2.100	4.3460	6
	(pCi/l ± one sigma standard error of counting)							
Gross alpha	11,900 ± 1,400	490 ± 50	3,050 ± 300	14	24,000 ± 1000	460 ± 30	3,205 ± 150	10
Gross beta	6,550 ± 590	30 ± 16	280 ± 7	14	6,440 ± 550	530 ± 100	1,320 ± 200	6
Pb - 210	1,300 ± 100	15 ± 4	690 ± 52	4	1,200 ± 100	44 ± 4	--	2
Po - 210	14 ± 2	0.95 ± 0.35	4 ± 0.5	4	10 ± 1	3.4 ± 0.4	--	2
Ra - 226	1,650 ± 50	30 ± 9	280 ± 7	14	2,500 ± 800	7.0 ± 0.2	295 ± 5	10
Th - 228	0.6 ± 0.3	-0.1 ± 0.1	0.0 ± 0.1	5	0.1 ± 0.1	-0.2 ± 0.2	--	2
Th - 230	1,400 ± 100	0.2 ± 0.1	3.3 ± 0.5	5	210 ± 10	0.1 ± 0.1	--	2
Th - 232	4.0 ± 0.2	0.0 ± 0.1	0.0 ± 0.1	5	0.1 ± 0.1	0.0 ± 0.1	--	2

demonstrated in Table 7.2, a seven-fold reduction in average radium-226 and natural uranium concentrations in treated minewaters is found when 1975 data are compared with 1981-82 data.

TABLE 7.2 Comparison of 1975 Mine Dewatering Effluent Quality with 1981-82 Quality. Number of samples in parentheses.

Constituent	Flow-Weighted Means	
	1975*	1981-82**
Total Radium-226 (pCi/l)	71.2 (23)	10.5 (15)
Total Uranium-natural (mg/l)	7.25 (23)	1.0 (14)

* Calculated from data in U.S. EPA (1975).
** Calculated from data in EID files.

The quality of treated mine effluents during the period 1978 through 1982 is summarized for key constituents in Table 7.3. It is readily evident that substantial variability in water quality exists between the two major mining districts, as well as within each mining district. Most striking in this regard are the concentrations of total dissolved solids, sulfate, molybdenum, selenium, and radium-226.

The wide range in radium-226 concentrations reflects occasional poor operation of the radium treatment systems. Thomson and Matthews (1981) attribute these "upsets" to incomplete mixing of the mine waters with barium chloride and to poor settling of the barium-radium sulfate precipitates. Variability in molybdenum, selenium, sulfate, and total dissolved solids, on the other hand, cannot be attributed to ineffectual treatment. This variability instead reflects chemical differences in the ground waters discharged from the mines, as indicated in Table 7.1.

As would be expected, sludges which accumulate in the minewater treatment pond bottoms as a result of settling, floculation, and precipitation are highly concentrated in radium-226 and other radionuclides. Analyses presented by Perkins and Goad (1980) and additional data in EID files indicate that the radium-226 concentrations in the accumulated sludges probably average more than 200 pCi/gram. Under standards proposed by EPA (1976), uranium mine wastes with a radium-226 concentration in excess of 5 pCi/gram would be treated as hazardous materials and subject to special handling and disposal procedures.

7.3 EFFECTS OF MINE DEWATERING EFFLUENTS ON SURFACE-WATER QUALITY

The previous chapter discussed the significant effects that discharge of minewater effluents has had on the hydrology of watercourse in the Grants Mineral Belt. Effects on water quality have been similarly significant. This section discusses how the quality of these effluents differs from the quality of runoff that constitutes the natural water quality of the stream and how the quality of these artifically maintained streams changes as the waters flow downstream.

7.3.1. Comparison of the Quality of Mine Dewatering Effluents with Natural Runoff Quality

Under natural, pre-mining conditions, watercourses receiving mine dewatering effluents, such as San Mateo Creek and the Puerco River, often have low flows or are even dry. When flow occurs in these watercourses, it is the result either of storm runoff or of runoff from snow melt. Therefore, comparison of the quality of mine dewatering effluents with natural storm runoff collected by EID personnel. Number of samples in parentheses.

CONSTITUENT	AMBROSIA LAKE MINING DISTRICT					CHURCH ROCK MINING DISTRICT				
	MAX.	MIN.	MEDIAN	AVG.		MAX.	MIN.	MEDIAN	AVG.	
mg/l										
TDS	2,615	510	1,610	1440	(26)	1,190	360	452	580	(16)
SO_4	1,370	185	755	655	(22)	600	60	136	210	(17)
As	0.20	<0.005	0.011	0.02	(26)	0.02	<0.005	<0.005	0.007	(16)
Ba	1.7	0.1	0.21	0.24		2.1	0.10	0.413	0.5	(15)
Mo	3.2	0.03	0.80	1.0	(27)	0.6	0.01	0.01	0.2	(15)
Se	1.0	0.01	0.09	0.24	(27)	0.3	0.01	0.04	0.07	(15)
U natural	3.0	0.2	1.56	1.5	(26)	1.8	0.6	1.07	1.0	(14)
V	0.29	<0.01	0.029	0.08	(21)	0.07	0.01	0.012	0.02	(13)
pCi/l ± SE*										
Gross alpha	1,760 ± 100	54 ± 14	635 ± 70	780	(14)	1,200 ± 100	280 ± 30	440 ± 40	600	(11)
Gross beta	945 ± 225	84 ± 16	377 ± 125	435	(6)	663 ± 125	322 ± 30	460 ± 74	480	(6)
Pb - 210	33 ± 6	6.9 ± 2.6	14 ± 5	15	(9)	10 ± 2	4.5 ± 2.3	--	--	(2)
Po - 210	14 ± 2	0.95 ± 0.35	1.1 ± 0.4	6	(4)	15 ± 5	3.4 ± 0.4	9.8 ± 7.4	10	(13)
Ra - 226	200 ± 10	0.12 ± 0.04	6.4 ± 1.2	27	(28)	89 ± 5	0.67 ± 0.2	2.0 ± 0.2	10	(13)
Ra - 228	0 ± 2	0 ± 2	0 ± 2	0	(5)	<0.2	<0.2	--	--	(2)
Th - 228	<0.3	<0.1	<0.1	0.2	(3)	0 ± 2	0 ± 2	--	--	(2)
Th - 230	4.0 ± 0.5	<0.3	0.7 ± 0.2	1.7	(3)	3.9 ± 0.5	<0.2	--	--	(2)
Th - 232	<0.1	<0.1	<0.1	<0.1	(3)	<0.2	<0.2	--	--	(2)

*SE = Standard Error of Measurement (one sigma) quality provides an indication of how the change from ephemeral to artificially-maintained perennial watercourses has affected chemical quality.

Suspended Sediment

In all effluent-dominated watercourses, suspended sediment concentrations under minewater baseflow conditions are smaller than the concentrations borne by thunderstorm runoff (see Chapter IV). EID and uranium industry self-monitoring data indicate that these simple treatment measures, used to remove radium-226 before discharge to watercourses ~~usually~~ reduce suspended sediment concentrations from more than 100 mg/l in the untreated minewater to less than 10 mg/l in the final effluent. Runoff has average suspended sediment concentrations greater than 30,000 mg/l.

Although treated minewaters are relatively free of sediment when they are discharged, they eventually become burdened with suspended silts and clays. Stream channels in the Grants Mineral Belt which receive mine dewatering effluents are relatively free of suspended sediments just below the point of minewater discharge. Silt and clay particles are entrained from the channel bed as flow continues downstream. On November 13, 1980, for example, suspended sediment concentration increased from 52 mg/l below the Kerr-McGee Church Rock I mine outfall in Pipeline Arroyo to 3500 mg/l in the Puerco River in Gallup approximately 19 miles downstream. Similar trends were evident on other days as well.

San Mateo Creek in the Ambrosia Lake district also entrains sediment. The prevalence of sand over fine-grained sediments in the San Mateo Creek alluvium, however, causes suspended sediment concentrations, typically less than 400 mg/l, to be lower than in the Puerco River system.

Dissolved Solids

Concentrations of total dissolved solids (TDS) in minewaters are variable in the Grants Mineral Belt. In the western portions of the Ambrosia Lake mining district, mines produce waters with 1200 to 1800 mg/l TDS (Perkins and Goad, 1980). These concentrations are reflected in Arroyo del Puerto, where TDS concentrations are often 1500 to 2,000 mg/l. Mixing of mine dewatering effluents with natural waters resulting from runoff occasionally dilutes TDS levels in this watercourse to less than 1,000 mg/l. Minewaters discharged to Arroyo del Puerto thus bear about twice the concentration of dissolved solids of that in natural runoff in the area, which is typically below 1,000 mg/l TDS.

In contrast, minewaters produced in the Church Rock and the eastern portion of the Ambrosia Lake districts usually contain only a few hundred mg/l TDS. Data presented by Perkins and Goad (1980) demonstrate that effluents discharged to Pipeline Canyon and San Mateo Creek contain only 300 to 600 mg/l TDS. TDS values in natural runoff are quite similar. In the these areas, therefore, minewaters have not influenced the TDS concentrations of receiving streams. It is noteworthy that the TDS concentrations are only one-fourth of those found in western portion of the Ambrosia Lake minewaters despite the fact that all minewaters are produced largely from the Morrison Formation. High TDS concentrations in the western portion of the Ambrosia Lake district have been attributed to greater mineralization of the host rock and to dewatering-induced leakage of more saline ground water into the mines from the overlying Dakota Formation (Brod, 1979; Kelley and others, 1980).

e relative concentrations of specific ions in minewaters appear to differ from concentrations found in natural runoff. Analysis of Figures 7.1 and 7.2 indicates that minewaters generally have proportionally more sodium and sulfate than natural runoff.

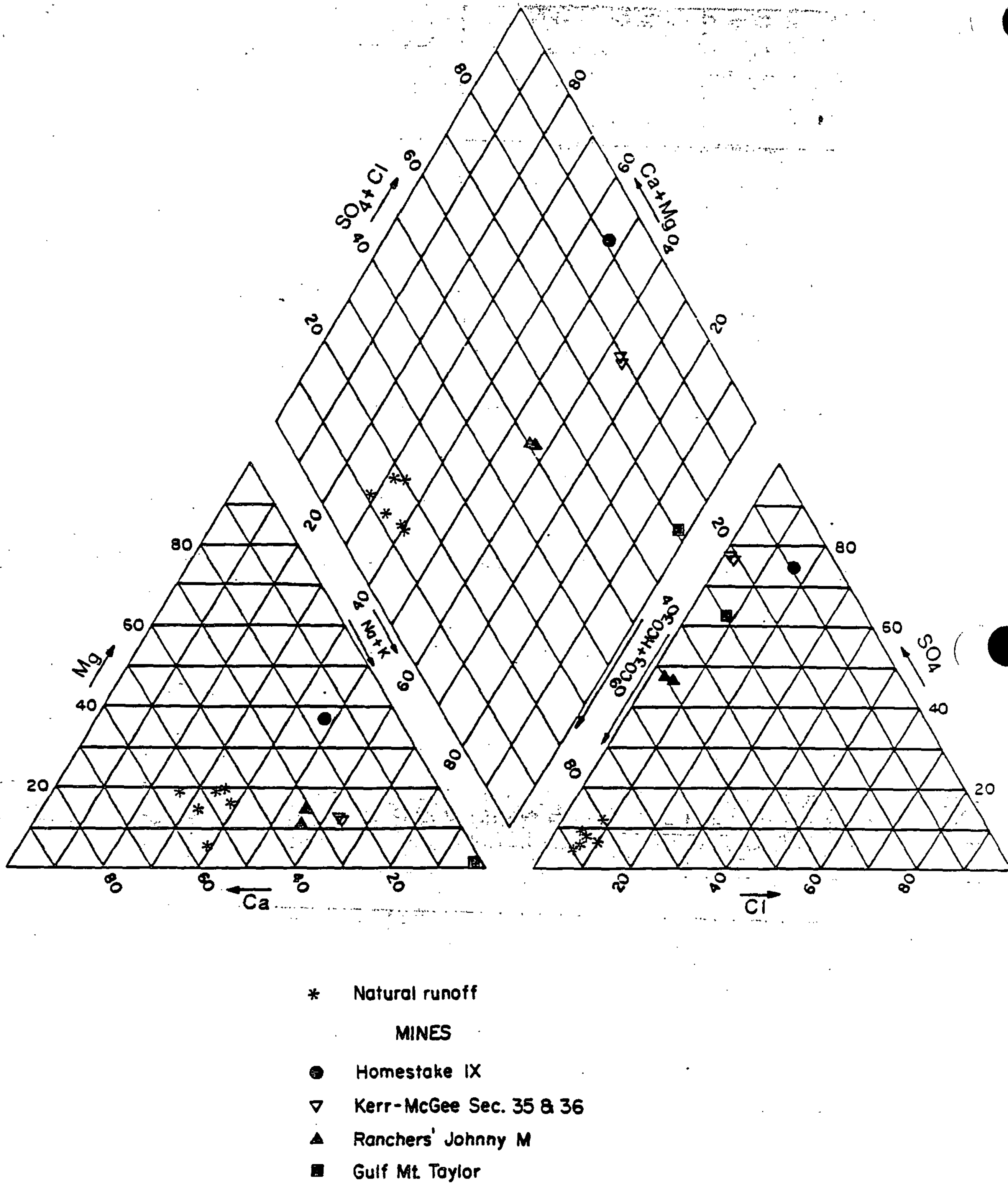


FIGURE 7.1 Comparison of the ionic composition of mine dewatering effluents and natural runoff, Ambrosia Lake mining district. Ions are expressed as percentage of total equivalents per liter.

Total versus Dissolved Concentrations

In contrast to natural runoff in which contaminants are largely associated with suspended sediment and precipitates, trace elements and radionuclides in treated minewaters are generally present in the dissolved form. The proportions of minewater contaminants in the dissolved phase are highly variable, but typically the dissolved fraction of a contaminant constitutes more than 50 percent of the total concentration (Table 7.4). Usually, more than 85 percent of the total concentration of gross alpha activity, molybdenum, selenium, and natural uranium in minewaters is in the dissolved fraction. Dissolved radium-226 proportions average about 30 percent of the total concentration.

The following discussion of trace elements and radionuclides focuses on comparison of total constituent concentrations in treated minewaters with total concentrations in natural runoff. Direct comparisons of dissolved concentrations are limited by the amount of available data. Nonetheless, based on information in Table 7.4, it can be assumed for many contaminants that even if minewaters and runoff have nearly equivalent total contaminant concentrations, then the dissolved concentrations in minewaters are probably significantly greater than in natural runoff, particularly for gross alpha particle activity, molybdenum, selenium, and natural uranium.

Trace Elements

Of the nine trace elements routinely analyzed in treated minewaters, only the concentrations of molybdenum, selenium, and uranium are consistently higher than in natural runoff (Figure 7.3). Since these trace elements are known to be naturally associated with uranium ores, their presence in surface watercourses suggests that the watercourse is receiving mine dewatering effluents. Arsenic, vanadium, and barium are occasionally detected in significant concentrations in minewaters, the latter because it is added in the treatment process to remove radium-226. Cadmium, lead, and zinc are usually below detectable levels in dewatering effluents and are therefore judged not to be of concern in these waters.

Uranium is the trace element with the highest concentrations in mine effluents throughout the Grants Mineral Belt. The median concentrations of total uranium in Ambrosia Lake and Church Rock effluents of 1.6 and 1.1 mg/l, respectively, are over 16 and 37 times greater than the median concentrations of natural runoff in the districts.

Molybdenum levels in minewaters vary from extremely low levels to more than 3 mg/l. Discharges in the Ambrosia Lake district have median total molybdenum concentrations of 0.80 mg/l. In comparison, only a small fraction of the natural runoff samples collected during this study contained detectable concentrations (> 0.01 mg/l) of total molybdenum. Lower concentrations are found in the Church Rock district, where the median total molybdenum concentration in effluents is 0.01 mg/l.

The third element that is consistently higher in mine dewatering effluents than in natural runoff is selenium. Treated effluent normally contains less than 0.04 to 0.09 mg/l selenium, but a few Ambrosia Lake mines discharge effluent with selenium concentrations approaching 1.0 mg/l. In contrast, data indicate median total selenium levels in natural runoff of 0.03 mg/l in Ambrosia Lake district and <0.005 mg/l in the Church Rock district.

Other metals that occasionally appear in dewatering effluents are arsenic and vanadium. Elevated levels of arsenic and vanadium appear to be restricted to one facility in the region. The discharge from the Homestake ion exchange facility in Ambrosia Lake contains average total arsenic and vanadium concentrations of 0.05 and 0.17 mg/l, respectively.

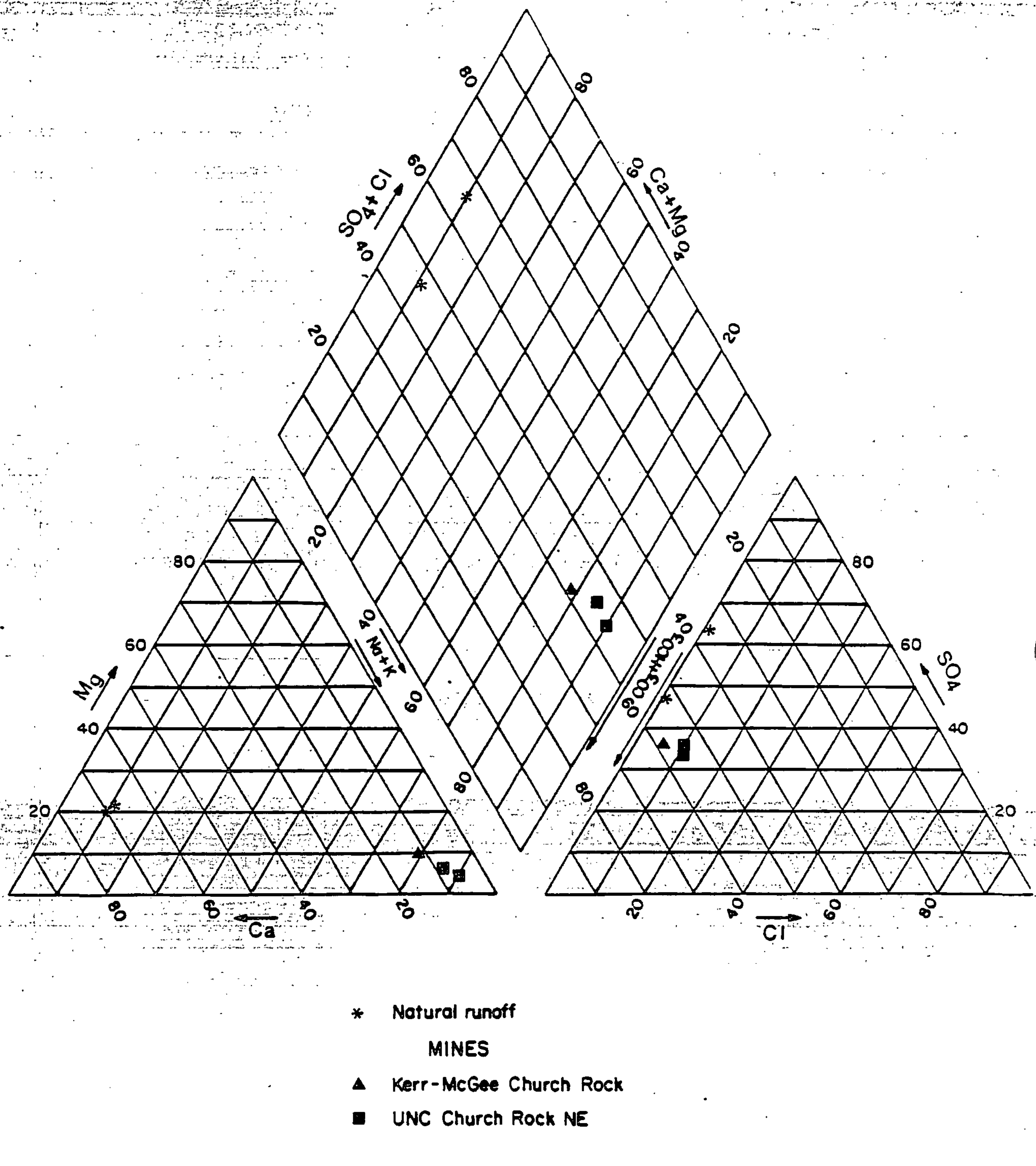


FIGURE 7.2 Comparison of the ionic composition of mine dewatering effluents and natural runoff, Church Rock mining district. Ions are expressed as percentage of total equivalents per liter.

TABLE 7.4 Percentage of Total Constituent Concentrations in the Dissolved Phase of Treated Minewaters, Ambrosia Lake and Church Rock Mining Districts, 1980.

CONSTITUENT	NO. OF SAMPLES	PERCENT IN DISSOLVED PHASE	
		RANGE	MEAN
As	3	12 - 90	57
Ba	5	<35 - 100	<71
Mo	6	88 - 100	95
Se	5	83 - 100	93
U-natural	5	68 - 100	89
V	5	20 - 100	61
Gross alpha	6	82 - 100	94
Gross beta	5	72 - 100	93
Ra-226	6	2 - 71	32

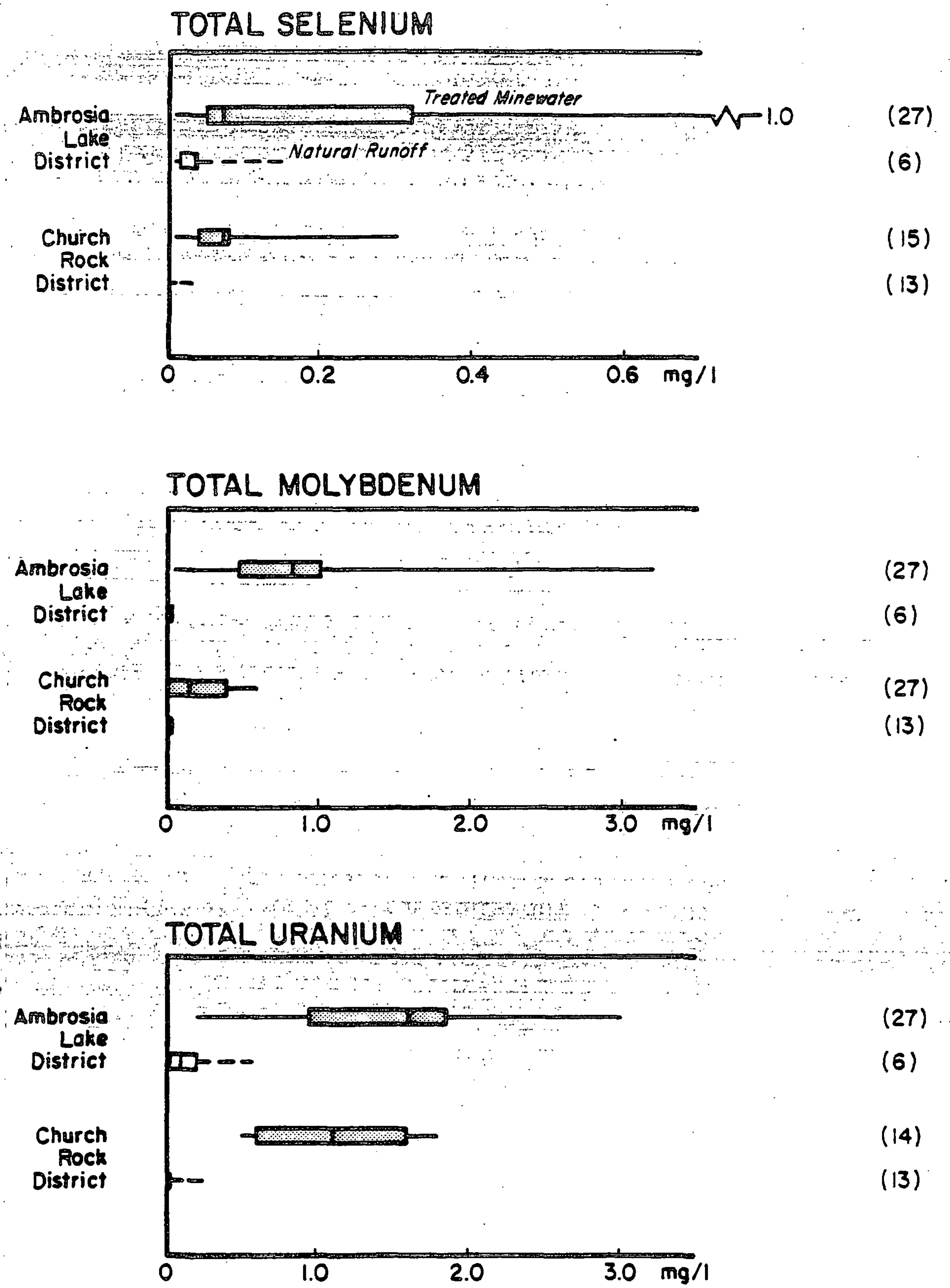


FIGURE 7.3 Comparison of selected total trace element concentrations in treated minewaters and natural runoff

Barium is of potential interest because it is added as barium chloride to co-precipitate radium-226 from minewaters before their discharge to watercourses. Median total barium concentrations in natural runoff in Ambrosia Lake and Church Rock districts are 7.7 and 4.8 mg/l, respectively. These are many times greater than the concentrations of 0.212 and 0.413 in treated minewaters from these districts.

Radionuclides

With the exception discussed above of natural uranium, median total concentrations of radionuclides in treated minewaters are less than those measured for natural runoff (Figure 7.4). Compared to natural runoff, however, minewaters have a higher, usually considerably higher, percentage of total radionuclide concentrations associated with the dissolved phase. EID data indicate that as much as 99 percent of the gross alpha and gross beta particle activities of natural runoff are associated with precipitates and suspended sediment. In contrast, over 90 percent of this radioactivity in treated minewaters is normally associated with the dissolved fraction (see Table 7.4). Total suspended sediments in dewatering effluents are quite low (averaging about 5 mg/l).

The total gross alpha particle activity of dewatering effluents is comparable to natural runoff levels. Dissolved gross alpha levels of several hundred to over 1,000 pCi/l in dewatering effluents, on the other hand, are ten to one hundred times greater than dissolved gross alpha levels in natural runoff (normally less than 20 pCi/l). On average, dissolved uranium accounts for more than 80 percent of the observed total gross alpha activity. Other alpha-emitters in the uranium-238 decay series (chiefly, thorium-230, radium-226, and polonium-210) are present in small concentrations in the effluents relative to uranium (see Table 7.3).

Median total gross alpha and beta concentrations are roughly equivalent in Ambrosia Lake and Church Rock mine effluents. Maximum concentrations of these constituents in Ambrosia Lake discharges, though, are about 40 percent greater than in the Church Rock discharges. The differences are most likely due to more effective ion-exchange treatment of the minewaters in the Church Rock district.

Despite high concentrations of radium-226 in raw minewaters, most mines discharge minewaters with 6 pCi/l or less of total radium-226 (Figure 7.4). While an average of about 30 percent of the radium in these effluents may be in the dissolved form, natural runoff often exceeds 15 pCi/l in total radium-226, but is quite low in dissolved radium-226, usually less than 2 pCi/l. Three facilities, evidently sampled during "upset" conditions, discharged effluent containing 75, 89, and 200 pCi/l total radium-226, concentrations similar to concentrations in untreated minewater. Large influxes of dissolved radium-226 may be introduced to receiving watercourses from any mine with ineffective radium-removal processes.

None of the thorium isotopes or radium-228 are normally present in detectable levels in minewaters. Treated minewaters have exhibited up to 33 pCi/l of total lead-210 and up to 15 pCi/l of total polonium-210. Greater concentrations (several hundred pCi/l) may ocur during periods of ineffective minewater treatment. Although the data are limited, there does not appear to be significant differences between the Ambrosia Lake concentrations and those presented for the Church Rock district. Natural runoff, in comparison, typically contains between 40 to 90 pCi/l each of total lead-210 and polonium-210.

7.3.2. Fates of Minewater Constituents in Surface Drainage Channels

Of the trace elements and radionuclides identified earlier as being elevated above levels in natural runoff, only radium-226 and lead-210 are known to undergo significant partitioning

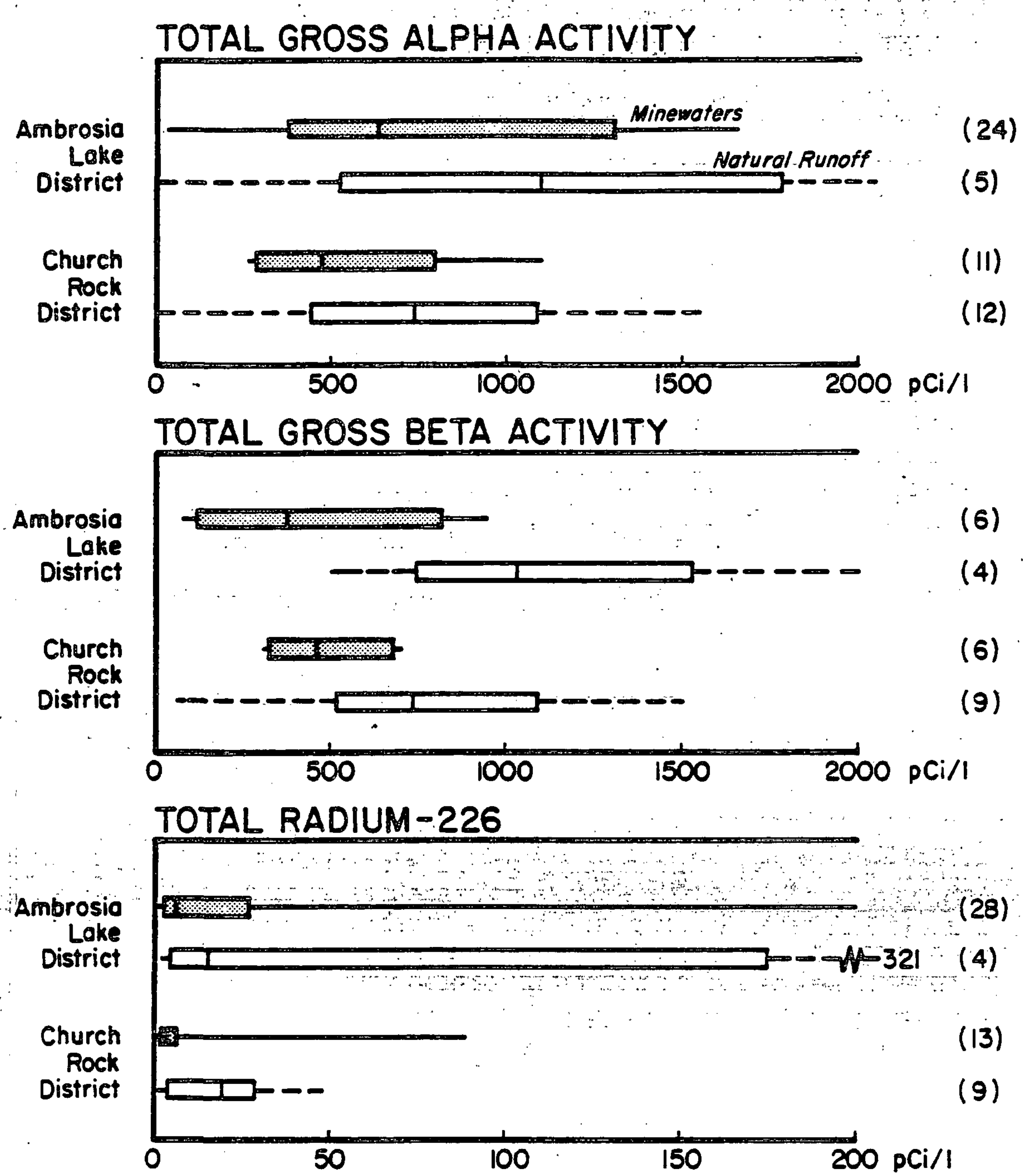


FIGURE 7.4 Comparison of total radioactivity in mine dewatering effluents and natural runoff

changes between dissolved and suspended phases as they travel downstream. These radionuclides are usually lost from solution shortly after their release to regional arroyos. Investigation of both dissolved and suspended phases revealed that precipitates and sediments suspended in the water account for virtually all these constituents. As shown in Table 7.5, a significant proportion of radium-226 is discharged to the Puerco River in dissolved form, but by the time radium-226 has travelled a few miles almost none remain in solution.

Once precipitated or bound to the stream sediments, minewater contaminants are subject to being moved downstream during normal artificially-maintained flows or, more significantly, during natural runoff events. During major streamflows, minewater-affected sediments are scoured from the stream bottoms, mixed with other sediments carried by the streamflows, and redeposited variable distances downstream. In drainages with sediment-rich streamflows, minewater-affected sediments generally become indistinguishable from other sediments carried along the watercourse and deposited on the stream bottom due to the large dilution factors involved and to the elevated levels of natural radioactivity in regional soils. Popp and others (1983) confirmed this along various drainages within the Rio Puerco watershed.

While dissolved radium-226 and lead-210 usually precipitate or are adsorbed by stream sediments, these radionuclides appear to stay in solution in stream channels that are relatively sediment free. Dissolved radium-226 concentrations along the Arroyo del Puerto, for example, consistently range between 3 and 6 pCi/l.

Unlike radium-226 and lead-210, the trace elements uranium, molybdenum, and selenium, and the major dissolved solids generally are not rapidly attenuated in the channels of receiving waters. These constituents generally remain in solution and move downstream with the minewater. Figure 7.5 shows downstream changes in water quality along the Puerco River on October 6, 1976 as an example (U.S. Geological Survey, 1977). The data show that constituents not precipitating or interacting rapidly with sediment decline gradually in concentration downstream, but still may be found in significant levels 50 miles from the mines. The declines in selenium and gross alpha concentrations are most likely related to decreasing pH levels downstream. While the initial dissolved radium-226 concentration is significantly elevated in contrast with the radium-226 levels measured during this study, concentrations nevertheless decline rapidly downstream. Similar responses have been found by the U.S. Geological Survey and the EID at more typical concentrations.

Table 7.5 Comparison of dissolved versus suspended concentrations of radium-226 at sites along the Puerco River. Data represent average concentrations. Number of samples in parentheses.

Site	Dissolved Ra-226 (pCi/l)	Total Ra-226 (pCi/l)	Suspended* Ra-226 (pCi/l)	River Miles From Mines
Church Rock Mines	3.2**(13)	9.98(13)	6.78	----
Puerco R. at NM 566	0.22 (14)	8.06 (13)	7.84	5.1
Puerco R. at Gallup	0.11 (12)	7.93 (12)	7.82	18.5

*Determined by subtraction.
**Estimate based on data in Table 7.4.

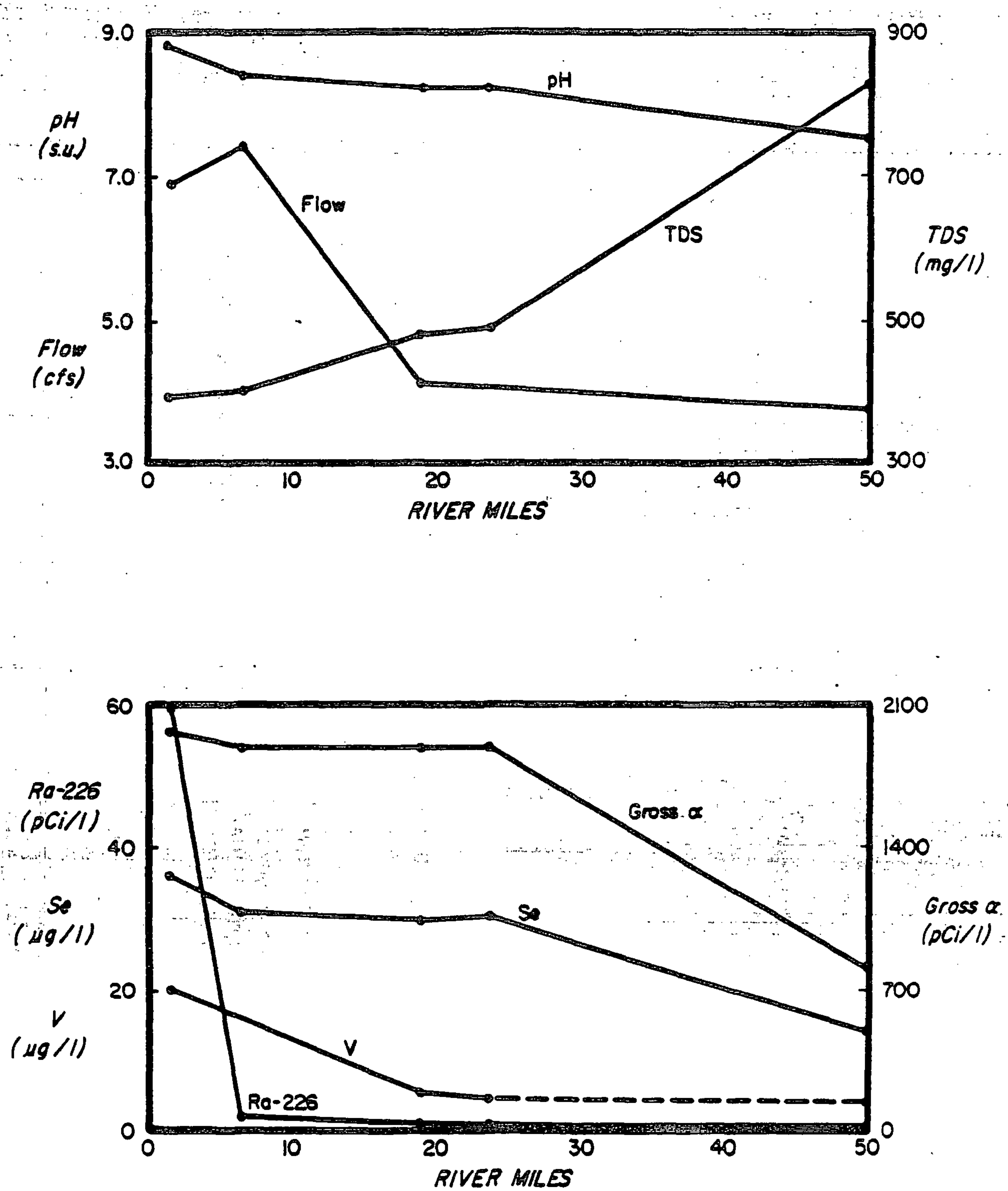


FIGURE 7.5 Water quality and flow along the Puerco River from the Church Rock mines to the New Mexico-Arizona border, October 6, 1976 (source: U.S. Geological Survey).

VIII. MINEWATER IMPACTS ON THE QUALITY OF SHALLOW GROUND WATERS

Release of dewatering effluents to Grants Mineral Belt arroyos greatly increased the volume of water infiltrating to shallow alluvial aquifers. This infiltration has been accompanied by a gradual change in the overall chemistry of these ground waters. In certain locations along San Mateo Creek and the Puerco River, the alluvial ground waters now bear a stronger chemical resemblance to minewaters than to natural waters. This condition is most pronounced in areas where stream-bottom leakage is high. Evaluation of this apparent change is somewhat hampered, however, by the lack of pre-mining ground water quality data.

Many of the impacts realized by surface waters are not experienced by underlying ground waters. Minewater constituents that adsorb to sediments or form insoluble precipitates do not usually reach ground waters. Chief among such constituents is radium-226. As shown previously, radium-226 quickly leaves solution in most Grants Mineral Belt streams, either by adsorbing to sediments or by forming insoluble precipitates, and thus is not found in significant concentration in alluvial ground water. On the other hand, chemical constituents that do not readily interact with earth materials or form insoluble precipitates, such as uranium, selenium or molybdenum, may be found in ground waters in concentrations approaching those in undiluted minewater and suggest ground water degradation from mine dewatering effluents.

Within the drainages studied effluent-dominated surface flows more closely approximate the infiltration capacity of the stream channel bottoms than those associated with natural runoff. The factor that most controls recharge volumes at any given location within these drainages, therefore, is duration of surface flow rather than flow rate or volume. Because of their perennial nature, effluents potentially may affect ground-water quality to a greater extent than would be projected from a comparison of volume of effluent-to-volume of natural runoff.

Variation of effluent seepage will cause fluctuations in ground water quality in the alluvium. For example, during spring runoff more dilution (mixing) of effluent with surface water takes place. This commingled water then may gradually with ground water in the alluvium. Under this condition, ground water quality is probably only locally affected. Conversely, under low-flow conditions and with the same amount of effluent discharged, ground water contamination may become more significant. Factors contributing to degradation of ground water quality include effluent quality and quantity, the amount of mixing of surface and ground water, permeability of the aquifer, surface and ground water quality, dispersion, advection, and the biological and geochemical processes taking place in the subsurface.

8.1 ESTIMATION OF NATURAL GROUND-WATER QUALITY

While the available data are limited, natural, alluvial ground-water quality can be generally described for some constituents. Pre-mining analyses in the Ambrosia Lake and Church Rock mining districts are limited in quantity and scope. Due to the rural nature of San Mateo Creek and the North Fork of the Puerco River, minimal testing of wells was performed before 1974. Most of the pre-mining data are limited to one-time samplings of a few isolated windmills for general chemical characteristics, e.g., sulfate and total dissolved solids, and there are no pre-mining trace element or radionuclide data available for either drainage. The following analysis of natural ground water quality in these drainages uses pre-mining data from stock wells 16-K-336 and 16-K-340 located along the

San Mateo Creek (Figure 8.2). There are no pre-mining data available for alluvial waters along the Arroyo del Puerto.

The most useful information for describing natural alluvial ground-water quality comes from wells drilled for and sampled during this assessment. In particular, data obtained from wells located upstream of uranium industry activities reflect the equivalent of pre-mining conditions at those locations. These wells include the BLM wells along the Puerco River (Figure 8.1) and the Lee wells along the San Mateo Creek in the Ambrosia Lake district in the Church Rock district (Figure 8.2)

8.1.1. General Chemistry

Superimposed on any local variabilities in alluvial ground water quality along the North Fork of the Puerco River are regional-scale quality changes. The available records suggest that natural alluvial ground water trends from a calcium sulfate water at the BLM cluster near Pinedale Bridge to a sodium sulfate water at well 16-K-340, and subsequently to a sodium bicarbonate water near Church Rock at well 16-K-336. The ionic composition are presented in Figure 8.3. The calcium-rich water is reflective of gypsum ($CaSO_4$) and lime ($CaOH$) abundant in the soils near Pinedale. The proportion of sodium increases downstream after soils derived from rocks of Jurassic age are encountered (see Figure 2.5). All of these regional changes appear to be gradual trends in response to changes in the parent rocks.

Along the North Fork of the Puerco River, water quality is highly variable with respect to total dissolved solids (TDS) concentrations. TDS concentrations range from less than 200 to over 1500 mg/l and generally increase with increasing distance from the river channel. The relative proportions of principal cations and anions, however, do not appear to change appreciably with increasing distance from the channel.

Natural alluvial ground waters along the San Mateo Creek trend from a sodium bicarbonate water at the Lee wells to a sodium-sulfate-bicarbonate water at the Sandoval Ranch (Figure 8.4). The bicarbonate is reflective of limestone rocks near the village of San Mateo.

Natural TDS concentrations in San Mateo Creek ground waters range from 500 to 1,000 mg/l (Brod and Stone, 1981). Along the six-mile distance from the Lee wells near San Mateo downstream to the Sandoval Ranch windmill, TDS concentrations do not significantly change; the increase is from 540 to 650 mg/l.

There are no data to describe natural TDS concentrations downstream for the Sandoval Ranch, but concentrations are not expected to increase dramatically in the three-mile distance to the Otero well cluster location (see Figure 8.2). While San Mateo Creek alluvial waters downstream of the Sandoval Ranch could be affected by the inflow of Arroyo del Puerto alluvial ground waters, available data suggest that there was minimal alluvial water along the Arroyo del Puerto under pre-mining conditions (Kerr-McGee Nuclear Corp., 1981).

8.1.2. Molybdenum

Under natural conditions concentrations of molybdenum in alluvial ground waters along the North Fork of the Puerco River and San Mateo Creek are expected to be low. Molybdenum concentrations in ground waters produced from all BLM and Lee wells are very low, consistently less than detection limit of 0.010 mg/l. While there are no other ground water data available for estimating natural molybdenum concentrations, analyses

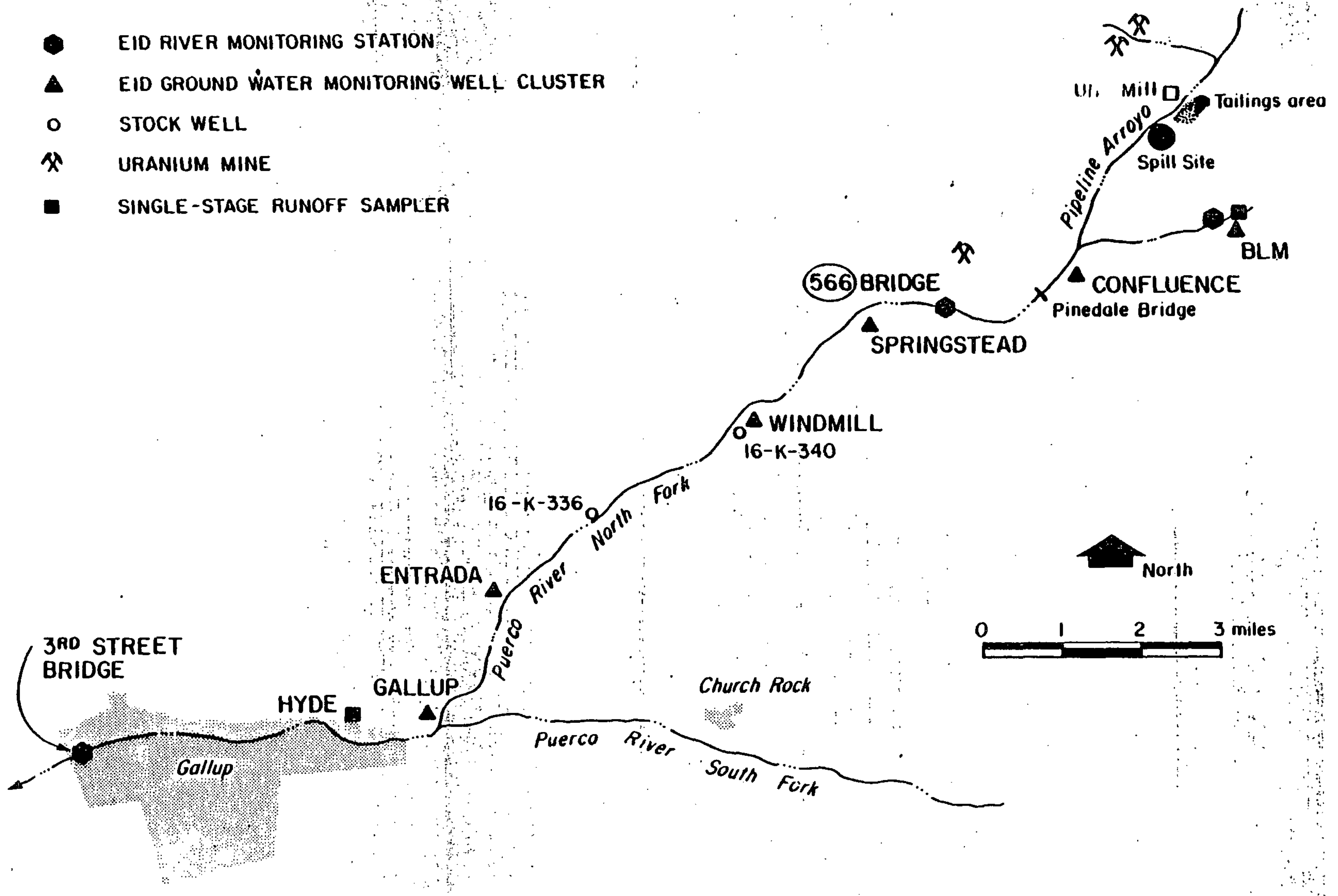


FIGURE 8.1 Well locations in the Church Rock mining district and along the Puerco River

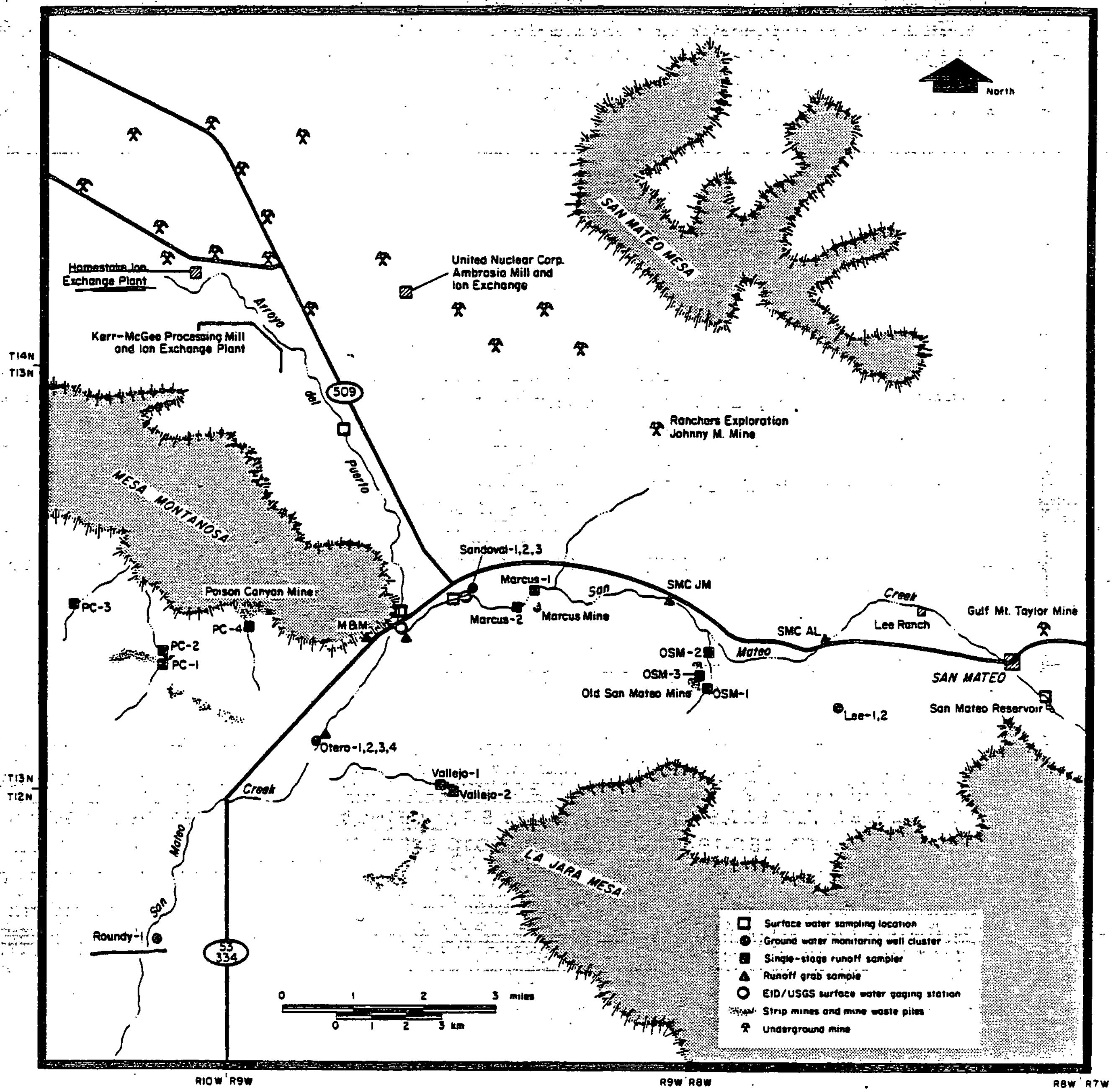


FIGURE 8.2 Well locations in the Ambrosia Lake mining district

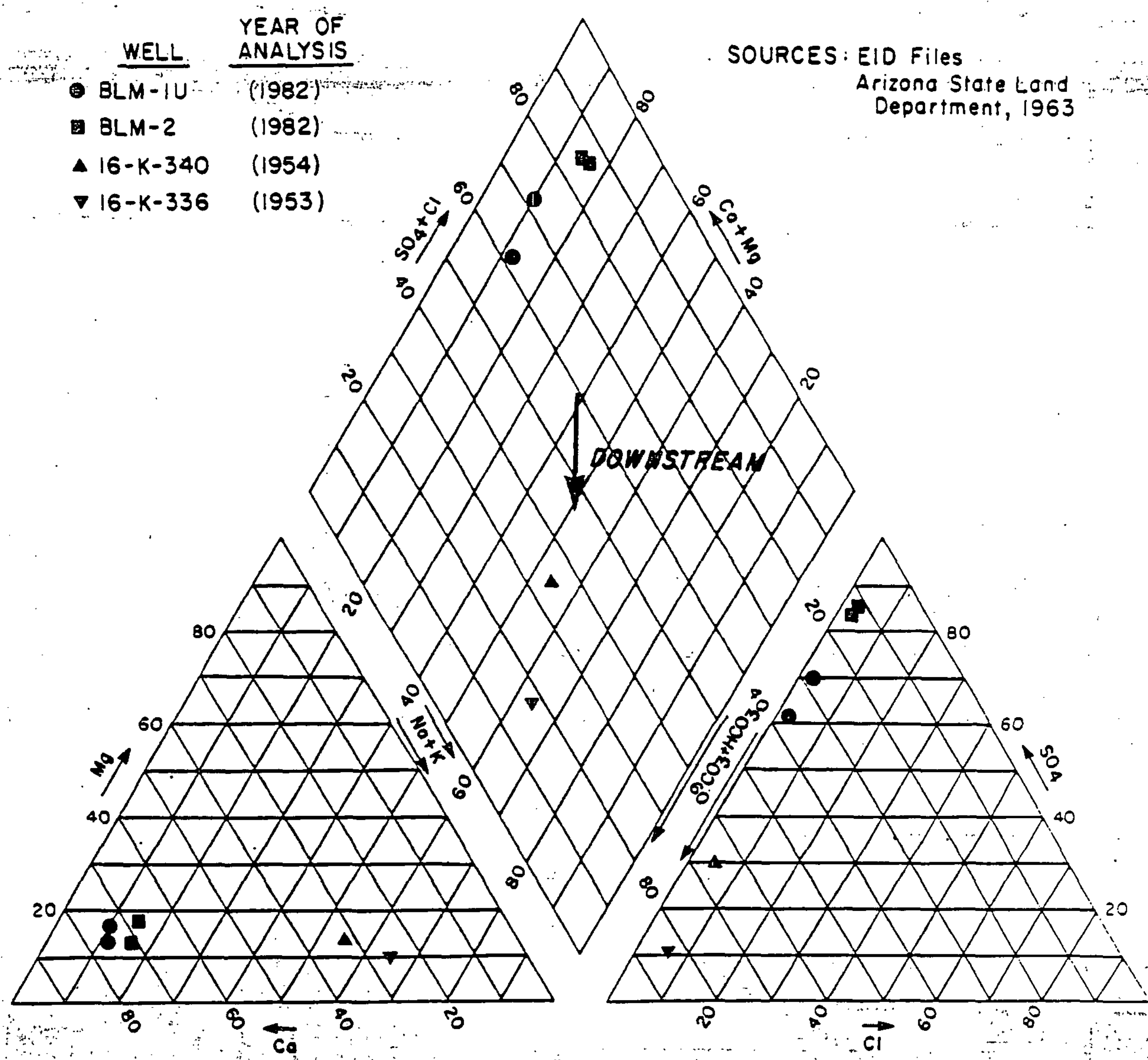


FIGURE 8.3 Natural alluvial ground water quality along the North Fork of the Puerco River

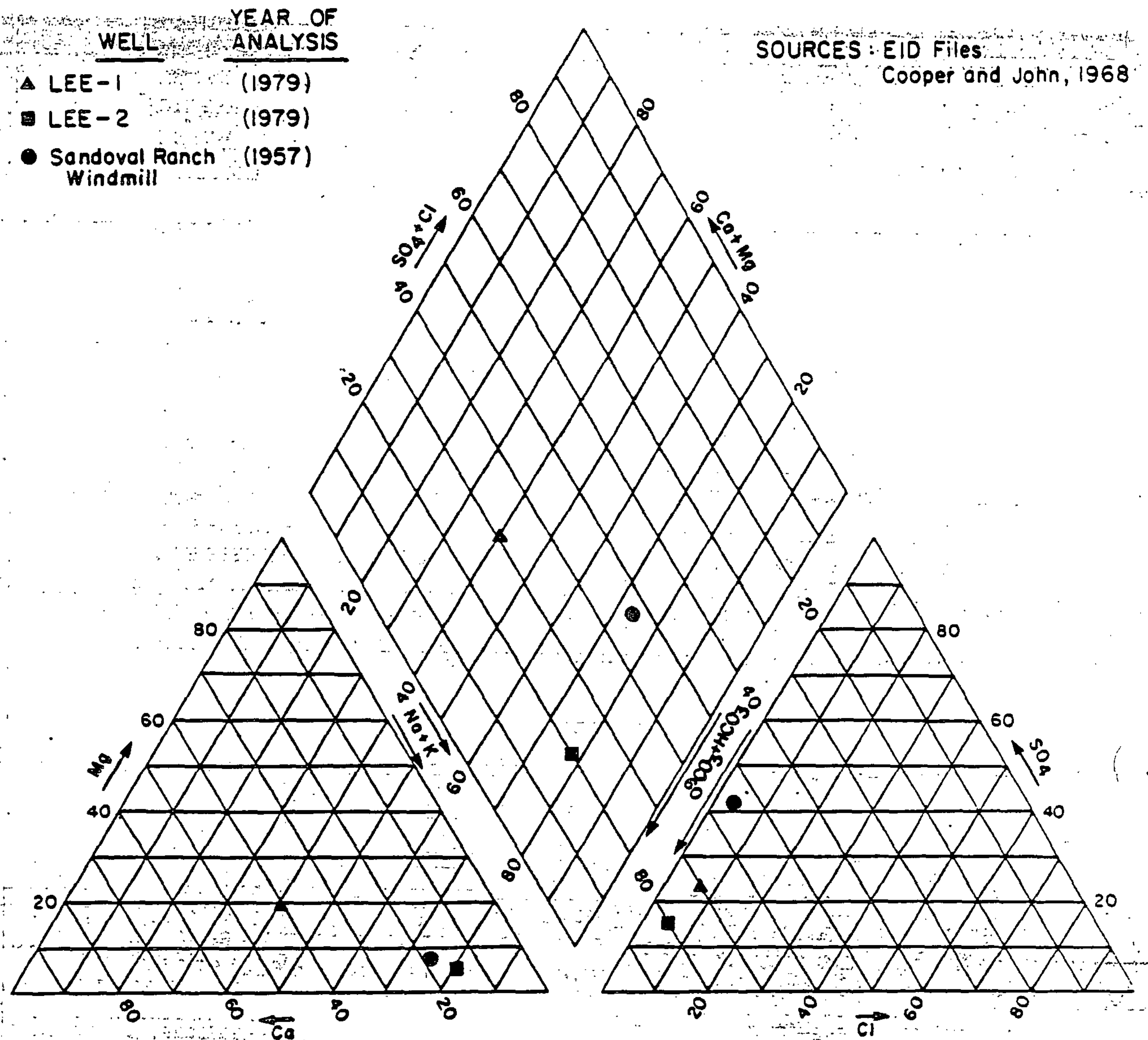


FIGURE 8.4 Natural alluvial ground water quality along San Mateo Creek

concentrations of 0.018 mg/l (EID files). Although minewaters have been discharged to the San Mateo Creek above this well since 1976, the depth of the well (130 feet) moderates the impacts of the mine discharges and, as a worst case, the 1980 selenium concentration represents an upper limit estimate of the pre-mining concentration. Natural selenium concentrations in ground water may increase downstream from the Sandoval Ranch because of the probable contribution of selenium-enriched Poison Canyon sediments to the San Mateo Creek alluvium.

8.2 IDENTIFICATION OF IMPACTS ATTRIBUTABLE TO MINE DEWATERING EFFLUENTS

Due to the lack of pre-mining data, comprehensive descriptions of the impacts of mine dewatering can not be made for all locations. At many locations, however, minewater impacts can be indirectly estimated after joint consideration of several pieces of hydrogeochemical evidence. The principal indicators that suggest if ground water has been impacted at a given location include the following:

1. Molybdenum concentrations in alluvial ground water greater than 0.03 mg/l. Mine dewatering effluents are the principal sources of dissolved molybdenum in the Puerco River and San Mateo Creek channels. Runoff from uranium mine waste piles may contain detectable levels of dissolved molybdenum, but due to the infrequency of runoff events and dominantly sediment-bound nature of the waste pile contaminants, significant impacts to ground water, if any, should be restricted to the immediate vicinity of the waste pile. The presence of molybdenum in concentrations greater than 0.03 mg/l in alluvial wells along these channels is indicative of the presence of mine dewatering effluents. The absence of molybdenum in these wells, on the other hand, does not mean that minewater impacts are not evident because not all effluents contain elevated levels of molybdenum (see Table 7.3).

2. Uranium concentrations greater than 0.06 mg/l in alluvial ground water along the North Fork of the Puerco River, and greater than 0.03 mg/l upstream and 0.1 mg/l downstream of the confluence of San Mateo Creek with Arroyo del Puerto. The values constitute the estimated upper limit concentrations found in these ground waters under natural conditions.

3. Selenium concentrations greater than 0.01 mg/l along the North Fork of the Puerco River, and greater than 0.15 mg/l along the San Mateo Creek upstream of its confluence with Arroyo del Puerto. Natural selenium concentrations along these river reaches are expected to be relatively low. Natural conditions below the San Mateo Creek-Arroyo del Puerto confluence cannot be projected because of the uncertainty regarding the added influence of selenium-enriched Poison Canyon sediment on ground water quality.

4. Major changes in total dissolved solids concentrations and in general ground water chemistry composition within a distance less than 3 miles. Natural changes in TDS concentrations and in composition are expected to be gradual; rapid changes in both are indicative of minewater effects.

5. Significant decline in molybdenum, uranium, or selenium concentrations with increasing depth in the upper portion of an alluvial aquifer. Contaminants contributed to the aquifer through stream bottom recharge (as is the case with minewaters) are expected to be more concentrated in the upper portion of the aquifer than contaminants naturally occurring in the ground water.

of unfiltered natural runoff indicate the virtual absence of molybdenum in sediments and natural waters in these drainages (see Table 4.3).

8.1.3. Uranium-natural

Statistical analyses have been performed on data from the North Fork of the Puerco River in attempt to estimate naturally occurring uranium concentrations in alluvial ground waters within that drainage (see Sinclair Probability Plots, section 3.4.1). These analyses allow differientation of natural ground waters from those influenced by uranium industry wastewaters (i.e., minewaters and the United Nuclear Corporation uranium mill tailings spill). Details of these analyses are given fully elsewhere (Gallaher and Cary, 1986) and are only summarized here.

Results of the analyses suggest that natural uranium concentrations for the North Fork of the Puerco River average approximately 0.02 mg/l and rarely exceed 0.06 mg/l. The estimated average natural concentration is identical to that suggested by U.S. EPA (1975). Average uranium concentrations at the BLM cluster range from 0.014 to 0.048 mg/l.

Natural uranium concentrations in alluvial waters along San Mateo Creek potentially may be higher than along the Puerco River. The abundant natural uranium ore outcrops in the San Mateo Creek drainage (for example, at Marcus and Poison Canyon mines; see Figure 8.2) probably contribute sediments enriched in uranium to the alluvium and these, in turn, contribute uranium to ground waters flowing in the alluvium. That natural runoff in the Ambrosia Lake mining district typically contains total uranium concentrations about three times higher than in the Church Rock mining district is indirect evidence for this mechanism (see Table 4.3).

While uranium concentrations at the Lee wells are consistently below the limit of detection (0.010 mg/l), the Lee wells are completed in alluvium largely derived from non-ore bearing rock material. As ground water flows downvalley from the Lee well cluster, natural uranium concentrations are anticipated to increase gradually as ground water flows through a more uranium-enriched alluvium. Pre-mining uranium concentrations at the Sandoval Ranch are estimated to have been less than 0.030 mg/l, based on interpretation of gross alpha activity concentrations obtained from a 1975 sampling of an alluvial windmill at the ranch (U.S. EPA, 1975). Natural uranium concentrations may increase further downstream. U.S. EPA (1975) estimated that background concentrations may approach 0.1 mg/l within the Ambrosia Lake mining district.

8.1.4. Selenium

Under natural conditions selenium concentrations in alluvial ground water along the North Fork of the Puerco River are expected to be uniformily low, that is, less than 0.01 mg/l. Average concentrations in the two BLM wells are <0.005 and <0.007 mg/l. Further, analyses of unfiltered natural runoff indicates the virtual absence of selenium in sediments and natural waters in this drainage (see Table 4.3).

In contrast, along San Mateo Creek, natural selenium levels may be significantly elevated. Selenium is known to be locally enriched in soils and plants in the Poison Canyon area (Cannon, 1953; Rapaport, 1963). It is noteworthy that median total selenium concentrations in natural runoff are over six times greater in the Ambrosia Lake mining district than in the Church Rock mining district (see Table 4.3).

Selenium concentrations in the Lee wells are generally undetectable (<0.005 mg/l). A 1980 EID analysis of the downstream Sandoval Ranch windmill showed selenium

8.3 CHANGES IN IONIC CHEMISTRY

Alluvial ground waters that are recharged primarily by dewatering effluents have been found to assume the ionic composition of the minewaters. Such water-quality changes are seen in areas of ground-water recharge along the Puerco River and San Mateo Creek. Pronounced changes in ionic composition of alluvial ground waters, for example, are seen at the Confluence test well cluster along the Puerco River. This well cluster is located about one mile below the confluence of Pipeline Arroyo, the channel receiving most of the Church Rock mine discharges, and the Puerco River. It is therefore immediately downgradient from the point where native ground waters are potentially affected by minewaters (see Figure 8.1).

Figure 8.5 shows that ground waters produced from wells CON-IL and CON-3 have ionic compositions similar to dewatering effluent and unlike natural waters, as represented by the BLM well cluster. Wells CON-IU and CON-2, on the other hand, produce waters more similar to natural waters. Ground water in well CON-3, which chemically most resembles the minewaters, also has a total dissolved solids concentration similar to minewaters (500 mg/l versus greater than 1000 mg/l at the BLM cluster). It is apparent that some water in the alluvial aquifer at that well cluster has been transformed from the strongly calcium-magnesium sulfate type to an intermediate type that tends toward sodium bicarbonate. Other test wells along the Puerco River that produce ground waters with ionic signatures similar to that for CON-3 are SPR-1, SPR-3U, GAL-1, GAL-2, and GAL-4. Because of the lack of pre-dewatering ground water quality data, it can not be definitely stated that all of these wells have been affected by the dewatering effluents.

The water quality of shallow ground waters in the San Mateo Creek-Arroyo del Puerto drainage has also been transformed by dewatering effluents. This change in major chemistry is most evident near the confluence of San Mateo Creek and Arroyo del Puerto (see Figure 8.2). One mile upstream along San Mateo Creek, alluvial ground waters at the Sandoval monitoring well cluster are of the sodium-sulfate-bicarbonate water chemistry type with a total dissolved solids concentration of about 650 mg/l (Figure 8.6). Although minewater from Ranchers Johnny M. Mine enters San Mateo Creek about 3 miles above the well cluster, no significant changes in ionic composition are evident in the test wells because of the close chemical similarity between minewaters and natural ground water at the site (see Sandoval Ranch windmill analysis, Figure 8.4).

In contrast, downstream from the confluence EID test wells on the San Mateo Creek produce alluvial ground water that bears a strong ionic resemblance to Ambrosia Lake minewaters. Figure 8.6 shows that ground waters at OTE-2, OTE-4, and RDY-1 now are all of the calcium-magnesium sulfate type, as are the minewaters introduced via Arroyo del Puerto. Corresponding to the shift in San Mateo Creek's alluvial ground water chemistry, total dissolved solids concentrations increased from about 650 mg/l at the Sandoval well cluster to over 2100 mg/l at the Otero well cluster, located three miles downstream.

8.4 TRACE ELEMENTS AND RADIONUCLIDES IN GROUND WATER

In addition to altering the dominant water chemistry and total dissolved solids concentrations of ground waters, infiltration of minewaters has elevated the concentrations of trace elements and gross radioactivity. Specifically, in test wells determined to have been affected by minewaters, the concentrations of uranium, molybdenum, selenium, and gross alpha particle activity are elevated above natural levels by 10 to 40 times. Evidence suggests that infiltration of mine effluents has caused similar responses elsewhere in the region beneath zones of significant stream bottom leakage

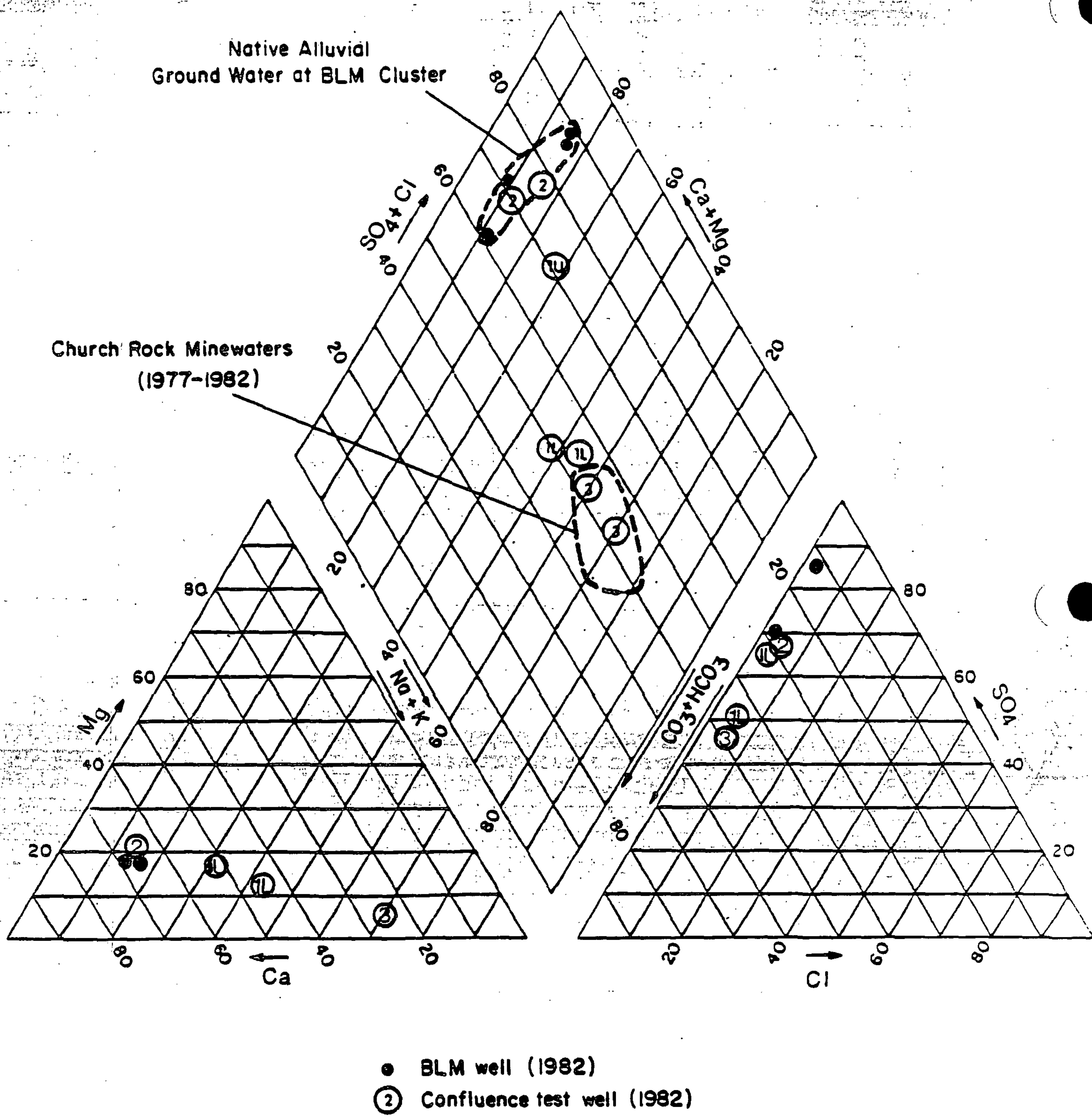


FIGURE 8.5 Ground water quality along the Puerco River near the BLM and Confluence well clusters.

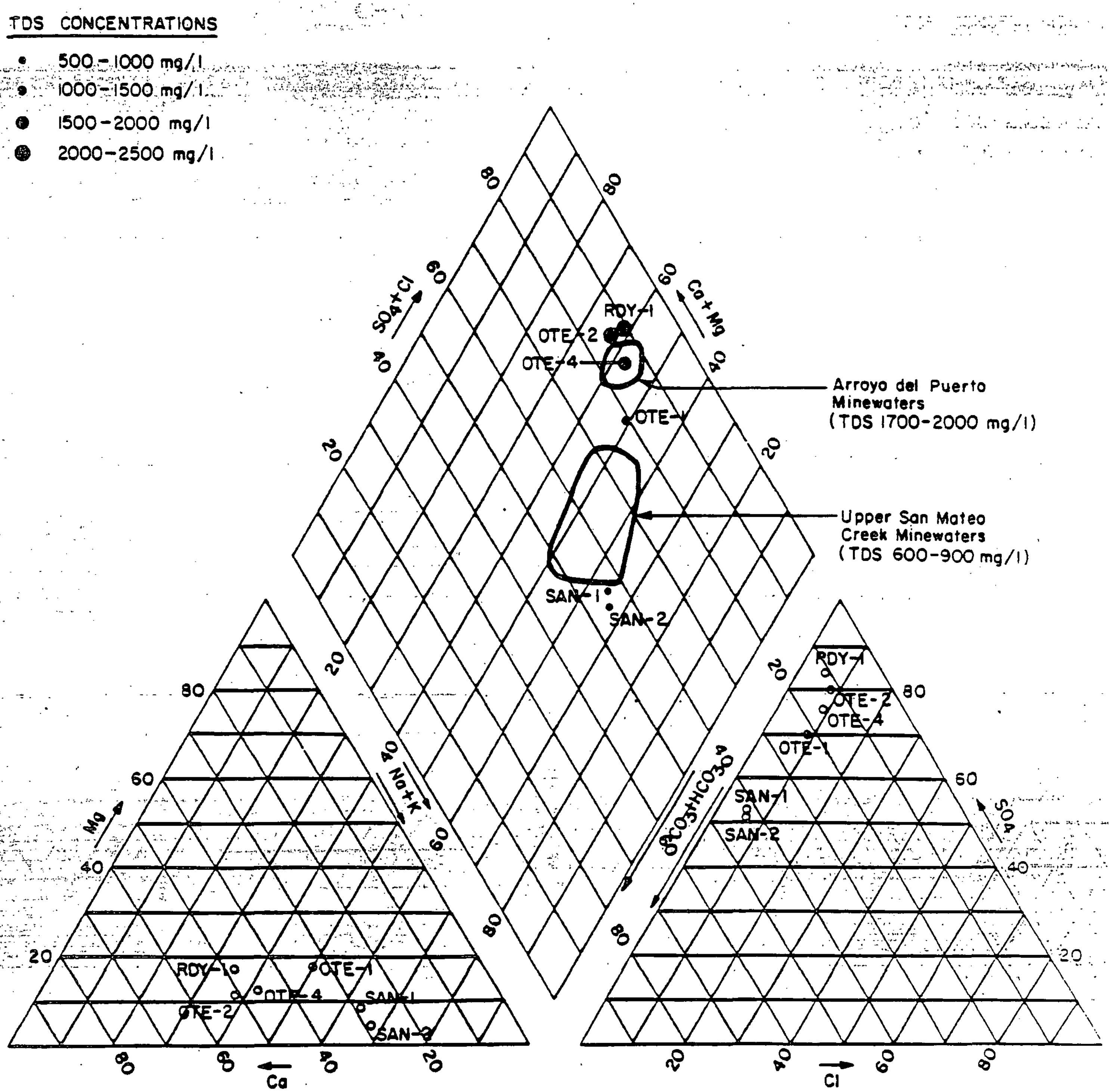


FIGURE 8.6 Ground water quality along San Mateo Creek

Degradation of ground water quality is most pronounced in the Ambrosia Lake mining district. This is to be expected for the following reasons: 1) approximately two-thirds of the historical minewater production from New Mexico uranium mining areas has been in this district (see Figure 6.1); 2) the quality of the discharged water overall is poorer than that in the Church Rock mining district (see Table 7.3); and 3) hydrogeologic conditions along Ambrosia Lake drainages result in relatively rapid infiltration of the wastewaters.

Table 8.1 shows mean contaminant concentrations detected in EID test wells along San Mateo Creek, the principal drainage of the Ambrosia Lake mining district. Uranium, molybdenum, and selenium concentrations at the Lee wells are below detectable levels of 0.005 to 0.01 mg/l. Uranium and molybdenum levels at the Sandoval well cluster are 10 to 20 times detectable limits due to infiltration of dewatering effluents. Other trace elements did not exhibit concentrations elevated above those found at the Lee wells.

Down valley below the confluence with the Arroyo del Puerto, uranium, molybdenum, and selenium concentrations are found to be approximately three times greater than at the Sandoval well cluster. Uranium and molybdenum concentrations in the Otero wells are as much 7 times greater than natural levels projected for this portion of the San Mateo Creek (see section 8.1) and therefore indicate that ground water at that location has been substantially degraded by minewaters. Moreover, both uranium and molybdenum, significantly decline in concentration with increasing depth. (For example, molybdenum concentrations decline from 0.38 and 0.28 mg/l in the shallower wells OTE-1 and OTE-2 (54 and 57 feet total depth, respectively) to < 0.01 mg/l in well OTE-4, a deeper well (72 feet total depth) in the same cluster.) Selenium is elevated in all the Otero wells, but is known to be naturally enriched in the area and can not be exclusively attributed to mine dewatering effluents. Generally, the pattern of trace element concentrations in the Otero wells coincides with that of the Sandoval wells (uranium > molybdenum > selenium)..

As with uranium, gross alpha particle activity concentrations are also significantly elevated along the San Mateo Creek below the Lee wells. These concentrations almost exclusively reflect the alpha radiation of uranium. Gross beta particle activities along the San mateo Creek are found in concentrations as much as 100 times those detected at the Lee wells. It is unknown which radionuclide(s) contribute principally to the gross beta concentrations.

Radium-226 concentrations may also increase due to minewater impacts, but the increases can not be verified due to the lack of pre-mining data. Table 8.1 shows radium-226 concentrations of about 0.05 pCi/l for the Lee wells. All but one of the other test wells along San Mateo Creek produce water containing more than 0.10 pCi/l of radium-226, on the average. Student-t and Mann-Whitney statistical tests show that the mean values for radium-226 in all the minewater-affected wells are significantly greater (95% confidence) than levels at the Lee wells. Despite the suggestion that minewaters have elevated radium-226 levels in alluvial ground waters, this increase is small and of little practical significance. A measureable amount of radium-226 may reach ground water, but most of the dissolved radium-226 in surface waters (up to 4 pCi/l) clearly does not.

Due to lack of pre-mining data, definitive statements can not be made regarding the influence of mine dewatering effluents at the Roundy well location, the most downstream well on the San Mateo Creek drainage The average uranium concentration of 0.13 mg/l is slightly above the EPA-estimated maximum natural level of 0.1 mg/l. In contrast, however, molybdenum is below analytically detectable levels. Selenium levels are greatly elevated, but because ground water quality is potentially influenced by Poison Canyon, where sediments are enriched in selenium, these levels can not be exclusively attributed to minewaters.

TABLE 8.1. Mean Trace Element and Radionuclide Concentrations in Wells in the San Mateo Creek Drainage, 1977-1982. Number of samples for each well is shown in parentheses and standard deviations are specified for all means. Well locations are indicated on Figure 8.2.

	WELLS ABOVE URANIUM MINE DISCHARGES		WELLS BELOW URANIUM MINE DISCHARGES					
	LEE-1 (13)	LEE-2 (14)	SAN-1 (13)	SAN-2 (12)	OTE-1 (14)	OTE-2 (15)	OTE-4 (12)	RDY-1 (12)
				ug/l				
As	ND	6.8 ± 1.7	ND	ND	ND	6.8 ± 3.4	ND	5.9 ± 2.4
Ba	133 ± 38	113 ± 18	112 ± 28	108 ± 22	112 ± 33	132 ± 50	124 ± 40	139 ± 38
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Mo	ND	9.6 ± 3.3	133 ± 60	131 ± 55	381 ± 115	257 ± 145	ND	ND
Se	ND	ND	18.5 ± 7.2	18.0 ± 7.7	80 ± 25	72 ± 25	102 ± 30	273 ± 128
U	ND	ND	222 ± 41	251 ± 79	754 ± 69	668 ± 144	166 ± 23	129 ± 11
V	ND	12 ± 2.7	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND
				pCi/l				
Ra-226** (pCi/l)	0.05 ± .02	0.04 ± .02	0.15 ± .03	0.09 ± .03	0.11 ± .03	0.15 ± .06	0.13 ± .02	0.15 ± .03
gross alpha	4 ± 2	6.6 ± 1.05	184 ± 38	209 ± 69	496 ± 49	463 ± 49	123 ± 19	92 ± 13
gross beta	3 ± 2	4 ± 2	89 ± 37	96 ± 39	300 ± 93	291 ± 92	72 ± 33	63 ± 19

*ND = not analytically detected
**Radium-226 values reflect samples analyzed by the New Mexico Scientific Laboratory Division (SLD); for uniformity data by Eberline Instrument Corp. were not used in calculation of the mean

The UNC uranium mill tailings spill in July 1979 greatly complicated the task of evaluating minewater impacts on alluvial ground waters in the Puerco River valley. The spill contained large concentrations of many radionuclides and trace elements, including the alpha emitters thorium-230 and uranium and the trace elements molybdenum, vanadium, and selenium. Thus, in all data collected since July 1979 there are always two potential sources for contaminants: the spill and minewaters. There are some pre-spill data for the Gallup cluster, but no pre-spill data exist for the Entrada, Windmill, Springstead, or Confluence well clusters.

Despite this major obstacle, the sources of elevated uranium in Puerco River valley ground waters are indicated through the use of the same probability techniques used to estimate natural uranium levels. These analyses allow differentiation of ground waters influenced by the spill from those influenced by minewaters. Whereas those ground waters that are high in both uranium and sulfate have been affected by the UNC spill, which was enriched in sulfuric acid, those wells that produce high uranium, but low sulfate, have been affected by minewaters, but not the spill. Only these results of these analyses (Gallaher and Cary, 1986) related to wells affected by minewaters are summarized here.

Mine dewatering effluents have degraded Puerco River alluvium with trace elements and radionuclides, although not to the same degree as along San Mateo Creek. Results of the aforementioned probability analysis suggest that fewer than one-third (6 of 21) of the EID wells along the Puerco River have been significantly impacted by uranium industry activities (minewaters and spill waters). Relatively low infiltration rates along this reach of the river effectively moderate the impacts to the underlying ground water.

Two test wells, SPR-1 and CON-3, were found to contain elevated levels of uranium attributable principally to minewaters. Table 8.2 summarizes the trace element and radionuclide concentrations found in these two wells and in BLM wells representative of natural alluvial quality. The data indicate a pattern of minewater effects similar to that documented along San Mateo Creek. Uranium and gross alpha particle activity are clearly elevated above natural levels in the two downstream wells. Molybdenum also shows increases above background although for SPR-1 the increase is negligible as it is the detectable limit. A small increase in selenium concentrations is suggested in CON-3 samples.

While minewater impacts along a given river reach may be relatively limited, they may be more significant further downstream if stream bottom leakage rates increase because of changing hydrogeologic conditions. The resultant ground water quality impacts would be highly site specific, depending on many factors including the infiltration rate, quality of the minewaters, and natural quality of ground water.

In reviewing the data for trace elements and radionuclides, it is clear that dewatering effluents are having similar effects throughout the Grants Mineral Belt. Uranium and gross particle alpha activity concentrations are often elevated in alluvial ground waters downstream from minewater discharges. Molybdenum usually appears elevated although there are exceptions. Selenium also reaches shallow ground water from minewater sources. Selenium, however, can also be locally elevated under natural conditions in Ambrosia Lake. Unless confirmed by evidence of low pre-mining concentrations, <u>the presence of elevated selenium is not alone sufficient to demonstrate contamination by mine dewatering effluents.</u>

TABLE 8.2. Mean Trace Elements and Radionuclides Concentrations of Selected Wells in the Puerco River Valley. Number of samples per well is shown in parentheses.

CONSTITUENT (ug/l)	WELLS ABOVE URANIUM MINE DISCHARGES		WELLS AFFECTED BY URANIUM MINE DISCHARGES	
	BLM 1U (2)	BLM-2 (2)	SPR-1 (1)	CON-3 (2)
	ug/l			
As	ND*	14	9	6
Ba	100	150	ND	180
Cd	ND	ND	ND	ND
Pb	ND	ND	ND	ND
Mo	ND	ND	10	170
Se	ND	7.5	5	11
U	14	48	145	433
V	ND	ND	ND	ND
Zn	ND	ND	ND	ND
	pCi/l			
gross alpha	10±3	28±10	56±15	278±10
gross beta	2.6 ± 2.9	16±4	NA**	118±22
Ra-226	0.13±0.06	0.32±0.10	NA	0.37±0.12

*ND = Not analytically detected
**NA = Data not available; analysis not requested

8.5 GEOCHEMICAL ATTENUATION OF MINEWATER CONSTITUENTS

Ground water quality data collected from EID wells in the Grants Mineral Belt show uranium, radium-226, selenium, and molybdenum concentrations and gross alpha particle activity that are above natural levels, but not as high as in the discharged minewaters. For most of these contaminants, however, ground water concentrations are of the same order of magnitude as in the sources.

Mechanisms which may reduce the contaminant concentrations include dilution surface adsorption, cation exchange, precipitation, hydrodynamic dispersion, and molecular diffusion. Dispersion and dilution may eventually reduce contaminant concentrations, but these processes are slow and may take years or even decades to be effective. Dilution, adsorption, cation exchange and precipitation are more likely mechanisms.

Decreases of uranium, for example, from more than 1.0 mg/l in minewaters to 0.5 mg/l in alluvial aquifers can probably be attributed to dilution by native ground waters. Uranium, molybdenum, and selenium all form anions in the geochemical environment of the Grants Mineral Belt and are therefore not greatly affected by some of the most effective attenuation processes, such as surface adsorption and cation exchange. These contaminants are therefore relatively mobile in both surface waters and shallow ground waters.

The tendency for uranium to precipitate from solution in Puerco River alluvium was analyzed using a computer program (WATEQFC) for calculating chemical equilibria of natural waters. Emphasis was placed on assessing the chemical stability of ground waters in EID wells most impacted by minewaters. Calculations were performed separately on natural uncontaminated ground water (BLM-1U) and on ground water dominated by mine dewatering effluents (CON-3). The predominant phase of uranium is calculated by the computer program WATEQFC to be di- oxide species. These complexes are subject to minimal adsorption because of their net negative charge and large molecular radii Tripathi, 1982; Langmuir, 1978) and are therefore very mobile in alkaline aqueous environments. Selected results of the geochemical modeling for the predominant uranium minerals are reported in Table 8.3.

The modeling output that all of the uranium species constituents are undersaturated with respect to their mineral phases by at least one hundred times. It can be inferred that uranium concentrations in the alluvial aquifer cannot be expected to decline solely as a result of long term equilibrium adjustment.

For dissolved radium-226, in contrast to uranium, the alkaline, oxidizing conditions found in the Grants Mineral Belt promote attenuation and discourage mobility. Because of its net positive charge, radium-226 is drawn to cation exchange sites on negatively charged clay minerals, organic matter, and metallic oxide coatings on the surfaces of alluvial materials. For surface and ground waters in the Grants Mineral Belt, only a small fraction of all radium-226 present remains in solution. Most radium-226 is probably immobilized in the stream channels sediments. Attenuation of radium-226 is so effective in Grants Mineral Belt alluvium that apparently minewaters increase the typical dissolved radium-226 concentrations normally carried by regional ground waters by only about 0.1 pCi/l.

TABLE 8.3 Selected Mineral Saturation Indices for Uranium in Puerco River Alluvial Ground Water.

Well No.	Sample Date (M-D-Y)	Mineral or Precipitate Phase	Formula	Saturation Index
BLM-1U	01-19-82	Tyuyamunite	$Ca(UO_2)_2(VO_4)_2$	-4.9
CON-3	01-20-82	Tyuyamunite	$Ca(UO_2)_2(VO_4)_2$	-2.7
		Carnotite-A	$K2(UO_2)_2(VO_4)_2{\cdot}3H_20$	-3.3
		Carnotite-B	$K2(UO_2)_2(VO_4)_2{\cdot}3H_20$	-3.5
		Schoepite	$UO_2(OH)_2H_20$	-3.6
		Coffinite	$USi0_4$	-4.4
		Rutherfordine	$U0_2CO_3$	-4.4

Although data are lacking for other uranium-238 decay products, it seems unlikely that any of the major daughter products from uranium mining activities could significantly degrade ground-water quality within the alkaline pH ranges typical of the minewaters. Thorium-230, lead-210, and polonium-210 all form cations in solution and their attenuation is likely to be as effective as radium-226 attenuation. Overall, the threat to ground water is judged to be small.

IX. EVALUATION OF WATER QUALITY

Earlier chapters have provided an overview of both natural water quality in the Grants Mineral Belt and water quality impacted by uranium mining. In order to evaluate the significance of observed water quality, current and potential uses that are made of the water in this area need to be considered along with relevant aspects of surface and ground water hydrology and the physio-chemical fate of minewater constituents. Furthermore, because of the radioactivity associated with both natural and mining-impacted flows, the quality of these flows needs to be compared with established standards and criteria for public exposure.

All surface waters in the Grants Mineral Belt, whether natural or mining-impacted, are used by livestock for watering. Only artificially maintained perennial streams, however, are used for irrigation or have potential use for domestic water supply. All three uses are made of ground waters. The contaminant and radioactivity levels of surface and ground waters in the Grants Mineral Belth raises concerns about the suitability of natural and mining-impacted surface waters and mining-impacted ground waters for present and potential uses.

9.1 WATER USES

Comparison of water quality with criteria and standards provides a means of evaluating whether water quality in the Grants Mineral Belt is consistent with current use. Livestock watering is the major use of surface waters. Watering from effluent-dominated streams is commonplace. Livestock even use turbid flows that may include both natural runoff and runoff from mine tailings.

Irrigation of gardens is practiced along the Puerco River from the Highway 566 bridge to the City of Gallup. Hoses are used to draw water up from the incised stream to gardens.

Ground waters are used as domestic water supply sources. The authors know of no documented domestic use of surface waters in the Grants Mineral Belt. Nonetheless, the potential for effluent-dominated streams, as modified in chemical quality by physio-chemical processes, to affect the quality ground waters provides sufficient rationale to evaluate such streams as sources of domestic water supply. Moreover, municipalities have considered the possibility of using dewatering effluents to supplement existing water supply sources (Hiss, 1980).

Selected criteria and standards for livestock watering, irrigation, and domestic water supply are given in Table 9.1. The only comprehensive evaluation of water quality necessary to support livestock watering remains that done by the National Academy of Sciences-National Academy of Engineering (NAS/NAE, 1972) for the EPA. The NAS/NAE recommendations are in the form of water quality criteria, that is, concentrations which, if not exceeded, are expected to be suitable to support a specific water use. NAS/NAE (1972) also recommended water quality criteria to support irrigation use. As part of the Molybdenum Project, the relationship between molybdenum levels in irrigation waters and plants was investigated (Vleck and Lindsay, 1977). The New Mexico Ground Water Regulations include standards designed to protect ground water quality for agricultural use (NM WQCC, 1983). These standards are used in this report for comparison purposes only. The regulations should be consulted for information on the applicability of the standards.

TABLE 9.1. Selected Criteria and Standards for Livestock Watering, Irrigation, and Domestic Water Supply.

CONSTITUENT	WATER USE					
	Livestock Watering	Irrigation			Domestic Water Supply	
	NAS/NAE	NAS/NAE	Molybdenum Project	New Mexico Ground Water Regulations	New Mexico Water Supply Regulations	New Mexico Ground Water Regulations
	mg/l					
TDS	3,000			1,000		1,000
SO_4				600		600
As	0.2	0.10		0.1	0.05	0.1
Ba				1.0	1.	1.0
Cd	0.050	0.010		0.1	0.010	0.01
Pb	0.1	5.0		0.05	0.05	0.05
Mo			0.020	1.0		
Se	0.05	0.02		0.05	0.01	0.05
U-natural				5.0		5.0
V	0.1	0.10				
Zn	25	2.0		10.0	5.	10.0
	pCi/l					
Gross Alpha[a]	15				15	
Combined Ra-226 and Ra-228	5	5		30.0	5	30.0

SOURCES: NAS/NAE - NAS/NAE (1972)
Molybdenum Project - Vlec[illegible]nd Lindsay (1977)
New Mexico Water Suppl[illegible]ulations - NM EIB (1985)
New Mexico Ground Wate[illegible]ulations - NM WQCC (1983)

Two sources of comparison were used to evaluate the quality of water for domestic use. Standards in the New Mexico Water Supply Regulations (NM EIB, 1985) are applicable to water emanating from water supply systems, not to surface and ground waters and are used only for comparison purposes. Similarly, the standards in the New Mexico Ground Water Regulations (NM WQCC, 1983) are not applicable to effluent-dominated streams and are used only for comparison purposes. Both sets of regulations should be consulted for information on their applicability.

As both natural water quality and the quality of waters affected or produced by uranium mining contain radioactivity, standards and criteria in the New Mexico Radiation Protection Regulations (NM EID, 1980) are used as a basis of comparison. The Radiation Protection Regulations are not applicable to natural water quality or uranium mining and the standards and criteria are used only for purposes of comparison. The regulations should be consulted for information on applicability.

9.2 NATURAL SURFACE WATERS

Perennial streams in the Grants Mineral Belt are limited in number, extent, and flow. The other natural source of surface water is runoff associated with storms and snowmelt. Without mine dewatering, runoff would be the surface waters in the Arroyo del Puerto, San Mateo Creek below the community of San Mateo, and the Puerco River. Both natural perennial streams and natural runoff may be used by livestock for watering.

The quality of perennial streams, which normally carry little sediment, is consistent with the livestock watering use. Trace elements and radioactivity concentrations, however, raise concerns about the suitability of natural runoff for this use. Furthermore, levels of radioactivity in natural runoff are sometimes excessive in comparison to health criteria and standards.

9.2.1. Perennial Streams

Dissolved concentrations of trace elements and radionuclides are naturally low in perennial streams in the Grants Mineral Belt. Comparison of natural water quality with livestock watering criteria for six trace elements, gross alpha particle activity, and radium-226 indicates that natural concentrations are normally much less than the criteria (Table 9.2). Similarly, the livestock criteria of 3,000 mg/l total dissolved solids (NAS/NAE, 1972) is almost double the mean natural concentration of 1530 mg/l found in the Rio Moquino at the Jackpile Mine. The Rio Moquino has higher dissolved solids concentrations than the Rio Paguate or San Mateo Creek below San Mateo Reservoir.

9.2.2. Natural Runoff

Trace elements and radionuclides are found to have highly variable levels in natural runoff resulting from storms. These levels are statistically correlated with the amount of suspended sediment carried by the water. Despite the high amounts of sediment that are sometimes carried by natural runoff, livestock may still use these waters. Therefore, natural runoff quality was compared with livestock watering criteria for the same six trace elements used for the comparison with perennial stream quality, but with very different results.

TABLE 9.2. Comparison of Dissolved Concentrations of Trace Elements and Radioactivity in Perennial Natural Waters with Livestock Watering Criteria.

CONSTITUENT	MEDIAN CONCENTRATION	LIVESTOCK WATERING CRITERIA[a]
	mg/l	
As	<0.005	0.2
Cd	<0.001	0.050
Pb	<0.005	0.1
Se	<0.005	0.05
V	<0.010	0.1
Zn	<0.050	25
	pCi/l	
Gross alpha	2	15
Ra-226	0.1	5[b]

[a] The criteria are from NAS/NAE (1972).

[b] The criterion applies to combined radium-226 and radium-228.

Measured total concentrations of trace elements and radioactivity indicate that natural runoff quality may not be consistent with its use for livestock watering (Table 9.3). Lead, vanadium, gross alpha particle activity, and radium-226 are the primary constituents affecting the suitability of natural runoff for livestock watering as median concentrations of all four constituents exceed criteria in both the Ambrosia Lake and the Church Rock mining districts. Even though the gross alpha particle activity criterion excludes alpha activity due to natural uranium, the median gross alpha activities of 1200 and 720 pCi/l in the Ambrosia Lake and the Church Rock mining districts, respectively, far exceed corresponding natural uranium medians of 68 and 20 pCi/l (at equilibrium, 1 mg/l of natural uranium is equivalent to 677 pCi/l).

Of lesser concern are arsenic and selenium in the Ambrosia Lake district and arsenic and cadmium in the Church Rock district because of exceedances of livestock watering criteria by maximum concentrations. The maximum concentration of cadmium measured in the Ambrosia Lake district is at the criterion level.

State limits on allowable concentrations of radionuclides that maybe discharged to unrestricted areas (that is, areas not controlled for the purposes of protecting an individual from exposure to radiation or radioactive materials) provide another means of evaluating the relative importance of radionuclides concentrations. These maximum permissible concentrations (MPCs), however, apply only to state-licensed facilities, not to natural runoff (see NMEID, 1980). Comparison of natural runoff quality with MPCs indicates that radium-226 is of concern in areas unaffected by the uranium industry in the Church Rock mining district and both radium-226 and lead-210 are of concern in similar areas in the Ambrosia Lake district (Table 9.4). Polonium-210 exceeds half its MPC in the Church Rock district; all other radionuclides are present in small amounts compared to MPCs. While these data are limited, it does appear that the radiological quality of natural runoff may be worse in the Ambrosia Lake district than in the Church Rock district.

While radium-226 and lead-210 sometimes exceed MPCs in uncontaminated, natural runoff, natural radiation levels may be a cause for concern even when these radionuclides simply approach MPCs. A sample from the South Fork of the Puerco River on September 21, 1982, provides a typical example (Table 9.5). Both radium-226 and lead-210 occurred at about 75 percent of their respective MPCs in this sample. Even though no radionuclide in the sample exceeded its MPC, the sum of the ratio of each radionuclide concentration to its MPC exceeds 1.00 (actual value, 1.66) and thus is in excess of specifications set forth in Part 4, Appendix A, Note 1 of the New Mexico Radiation Protection Regulations (NM EID, 1980). Uranium industry facilities licensed under these regulations are not permitted to release water of this quality to unrestricted areas. Yet, watercourses in the Grants Mineral Belt may receive water of this quality simply as a result of natural circumstances.

TABLE 9.3. Comparison of Total Concentrations of Trace Elements and Radioactivity in Natural Runoff with Livestock Watering Criteria.

CONSTITUENT	AMBROSIA LAKE MINING DISTRICT		CHURCH ROCK MINING DISTRICT		LIVESTOCK WATERING CRITERIA[a]
	Median	Maximum	Median	Maximum	
			mg/l		
As	0.13	0.26	0.08	0.30	0.2
Cd	0.006	0.05	0.003	0.06	0.050
Pb	0.52	2.0	0.17	2.0	0.1
Se	0.03	0.15	<0.005	0.03	0.05
V	0.61	3.2	0.40	0.92	0.1
Zn	1.5	1.7	0.38	8.5	25
			pCi/l		
Gross alpha	1,200	2,100	720	1,600	15
Ra-226	15	321	19	47	5[b]

[a] The criteria are from NAS/NAE (1972).

[b] The criterion applies to combined radium-226 and radium-228.

TABLE 9.4. Comparison of Total Radioactivity in Natural Runoff with Maximum Permissible Concentrations for Releases to Unrestricted Areas. All concentrations are in picocuries per liter (pCi/l).

ADIONUCLIDES	AMBROSIA LAKE MINING DISTRICT		CHURCH ROCK MINING DISTRICT		MAXIMUM PERMISSIBLE Concentration[a]
	Median	Maximum	Median	Maximum	
Pb-210	88	720	53	74	100
Po-210		43[b]	80	450	700
Ra-226	15	321	19	47	30
Th-228			22	43	7,000
Th-230			24	42	2,000
Th-232			24	43	2,000
U-natural	68	379	149	203	30,000

[a] The maximum permissible concentrations are from Table II of Appendix A to Part 4 of the New Mexico Radiation Protection Regulations (NM EID, 1980). The concentrations are not applicable to natural runoff and are used only for comparison purposes.

[b] Only a single measurement is available.

TABLE 9.5. Total Radionuclide Concentration/Maximum Permissible Concentration Ratios for the South Fork of the Puerco River on September 21, 1982.

RADIONUCLIDE	CONCENTRATION (pCi/l)	MPC[a] (pCi/l)	CONCENTRATION/MPC RATIO
Pb-210	74 ± 12	100	0.74
Po-210	90 ± 3	700	0.13
Ra-226	23 ± 6	30	0.77
Th-230	42 ± 4	2,000	0.02
U-natural	14	30,000	0.0005
		TOTAL	1.66

[a]The maximum permissible concentrations are from Table 11 of Appendix A to Part 4 of the New Mexico Radiation Protection Regulations (NM EID, 1980). The concentrations are not applicable to natural surface waters and are used only for comparison purposes.

9.3 URANIUM MINE WASTE PILES AND OPEN PITS

A potential concern about degradation of surface water quality from uranium mining is runoff from uranium mining operations - specifically, from mine waste piles and open pit operations. Both surface and underground mining produce waste piles. While the waste piles vary considerably in respect to ore content, the existence of the piles creates the potential for trace elements and radioactivity to be carried by runoff into surface water courses. Similarly, open pit mining exposes the ore body and creates the potential for contamination of surface waters through runoff. Furthermore, open pit mines have large waste piles nearby which may be subject to erosion.

Investigation of the largest open pit mine in the Grants Mineral Belt, the Jackpile-Paguate mine, indicates that while certain radioactive parameters are significantly elevated downstream from the mine, water quality both upstream and downstream is consistent with the livestock watering use. Investigation of mine waste piles in the Ambrosia Lake mining district, however, indicates that runoff from the piles is of a considerably lesser quality than natural runoff. Thus, such runoff is definitely not suitable for livestock watering and raises concerns about its levels of radioactivity. Similar results are expected to be found in the Church Rock district.

9.3.1. Runoff From Mine Waste Piles

Runoff from uranium mine waste piles exerts a potentially significant impact on surface water quality in the Grants Mineral Belt because of the trace elements and radioactivity associated with sediment carried by this runoff. Similar to the situation with natural runoff, livestock may ingest such turbid waters.

Total concentrations of arsenic, cadmium, lead, selenium, vanadium, gross alpha particle activity, and radium-226 found in mine waste pile runoff in the Ambrosia Lake District are not consistent with ingestion of this water by livestock (Table 9.6). This conclusion remains true even after the gross alpha activity is corrected for the alpha activity due to natural uranium (1 mg/l is equivalent to 667 pCi/l), which is not included in the livestock watering criterion. The median and maximum uranium values of 389 and 41,800 pCi/l are far below the measured gross alpha activity levels. In fact, for all constituents except arsenic, maximum concentrations are one to four orders of magnitude above livestock watering criterion. Even for arsenic, the maximum concentration exceeds the livestock watering criterion by over seven times. The median concentration of arsenic, though, is at its criterion level and selenium levels normally do not exceed its criterion.

Even though maximum permissible concentrations (MPCs) for release of radionuclides to unrestricted areas do not apply to runoff from mine waste piles, comparison with MPCs provides a means of evaluating the relative importance of radionuclides concentrations. Even median concentrations of lead-210 and radium-226 exceed MPCs by an order magnitude and maximum concentrations exceed MPCs two and three orders of magnitude, respectively (Table 9.7). While natural uranium concentrations are normally below its MPC, this level was exceeded by the maximum measured concentration.

TABLE 9.6. Comparison of Total Concentrations of Trace Elements and Radioactivity in Mine Waste Pile Runoff in the Ambrosia Lake Mining District with Livestock Watering Criteria.

CONSTITUENT	MEDIAN	MAXIMUM	LIVESTOCK WATERING CRITERIA[a]
	mg/l		
As	0.21	1.5	0.2
Pb	0.56	2.5	0.1
Se	0.03	0.85	0.05
V	1.1	24.8	0.1
	pCi/l		
Gross alpha	10,800	420,000	15
Ra-226	650	34,900	5[b]

[a] The criteria are from NAS/NAE (1972).

[b] The criterion applies to combined radium-226 and radium-228.

TABLE 9.7. Comparison of Total Radioactivity in Mine Waste Piles in the Ambrosia Lake Mining District with Maximum Permissible Concentrations for Releases to Unrestricted Areas. All concentrations are in mg/l.

RADIONUCLIDE	MEDIAN	MAXIMUM	MAXIMUM PERMISSIBLE CONCENTRATIONS[a]
Pb-210	1,000	30,050	100
Ra-226	650	34,900	30
U-natural	389	41,800	30,000

[a] The maximum permissible concentrations are from Table II of Appendix A to Part 4 of the New Mexico Radiation Protection Regulations (NM EID, 1980). The concentrations are not applicable to natural runoff and are used only for comparison purposes.

When the results of comparison with livestock watering criteria and MPCs are considered together, the obvious conclusion is that while the quality of natural runoff in the Ambrosia Lake mining district is poor, mine waste pile runoff is worse. While information on the quality of mine waste pile runoff in the Church Rock district was not collected, this same conclusion is expected to hold in that district also.

9.3.2. Effect of an Open-Pit Mine on Surface Water Quality

Streams above and below the Jackpile-Paguate open-pit mine are likely to be used for livestock watering. In comparison to water quality in the Rio Paguate and the Rio Moquino above the mine, total dissolved solids and dissolved levels of gross alpha particle activity and radium-226 are significantly elevated in the Rio Paguate below the mine. In addition, dissolved concentrations of some trace elements are slightly elevated.

Comparison of livestock watering criteria with dissolved concentrations below the mine indicates that all constituents except for gross alpha and radium-226 are much less than recommended criteria (Table 9.8). Only the recommended criterion for gross alpha activity is apparently exceeded. The criterion, however, based on the criterion for domestic water supply (NAS/NAE, 1972), excludes uranium and the mean natural uranium concentration of 0.12 mg/l below mine accounts for 81 pCi/l of alpha activity. Therefore, the gross alpha activity is within the standard and the streams both above and below the Jackpile-Paguate mine are suitable for livestock use.

9.4. RELATIONSHIP OF RUNOFF QUALITY TO STREAM QUALITY

Under natural conditions (i.e., without mine dewatering), flow in San Mateo Creek below the community of San Mateo and the Puerco River consists of waters derived from runoff. Comparison of natural runoff from storms with livestock watering criteria indicates that such waters are not suitable for livestock watering primarily because of excessive concentrations of lead, vanadium, gross alpha particle activity and radium-226. Data, while restricted to the Ambrosia Lake mining district, indicates that runoff from uranium mine waste piles is even less suited for livestock watering because of even higher concentrations of the same constituents.

Nonetheless, there are two lines of evidence that, when considered together, suggest that the direct effects of runoff, natural or uranium mine waste pile, on water quality are primarily local in extent. First, trace elements and radionuclides in runoff are bound up with sediment. Both trace element and radionulcide concentrations in runoff have been found to have linear, first-order statistical correlations with sediment concentrations. Further, leach tests did not produce significant leaching of trace elements from mine wastes. In addition, investigations of the partitioning of lead-210 and radium-226 between suspended and dissolved phases of runoff indicate that almost all of the radioactivity is associated with the suspended phase.

Secondly, sediments from an area become mixed with other sediments carried by the watercourse and thus diluted and then deposited along the stream bottom. The investigations of sediment deposition downstream from the San Mateo mine waste pile serve as a case example. Sediments originally identifiable as having the waste pile as their source on the basis of trace element and radionuclide concentrations,

TABLE 9.8 Comparison of Dissolved Concentrations of Total Dissolved Solids, Trace Elements, and Radioactivity in the Rio Paguate below the Jackpile-Paguate Mine with Livestock Watering Criteria.

CONSTITUENT	MEDIAN CONCENTRATION	LIVESTOCK WATERING CRITERIA[a]
	mg/l	
TDS	1,705	3,000
As	0.006	0.2
Cd	0.002	0.050
Pb	<0.005	0.1
Se	0.006	0.05
V	0.010	0.1
Zn	<0.25	25
	pCi/l	
Gross alpha	79 ± 18[b]	15
Ra-226	3.7 ± 0.14	5[c]

[a] The criteria are from NAS/NAE (1972).

[b] The gross alpha particle criterion excludes alpha activity due to natural uranium. Therefore, while the mean apparently exceeds the criterion, actually the gross alpha is accounted for by the mean natural uranium concentration of 0.12 mg/l, which is equivalent to 81 pCi/l.

[c] The radium criterion applies to combined radium-226 and radium-228.

eventually become so mixed with other sediments as to no longer be chemically distinguishable. This phenomon has been noted by Popp and others (1983).

Watercourses of the Grants Mineral Belt, nonetheless, are dynamic systems. While dilution and deposition of sediments serve as natural mechanisms that limit adverse water quality impacts of runoff, such sediments do not necessarily remain deposited on channel bottoms. Instead, storm runoff or flow resulting from mine dewatering may entrain sediment and thus result in resuspension, further mixture, and later redeposition downstream. Thus, re-entrainments and later redeposition serves as a process for carrying trace elements and radioactivity downstream in Grants Mineral Belt watercourses.

9.~~6~~ 5 IMPACT OF MINEWATER DISCHARGES ON SURFACE WATER QUALITY

In terms of both quantity and quality, discharged minewaters are the dominant type of surface waters in the Grants Mineral Belt. Treated minewaters are used directly for livestock watering and irrigation and thus should be evaluated for suitability for these uses. Further, they infiltrate to shallow alluvial aquifers and may thus secondarily be used as a source of domestic water supply. Therefore, direct comparison of treated minewater quality with domestic water supply standards indicate the changes in chemical quality, whether by natural means or treatment, that treated minewaters must undergo to be suitable as domestic water sources.

In the Ambrosia Lake mining district, the treated minewater constituents of greatest concern in relation to water uses are selenium, radium-226, and secondarily molybdenum (Table 9.9). Selenium normally exceeds standards and criteria established for livestock watering, irrigation, and domestic water supply. Selenium is of special concern as it remains soluble as minewaters flow downstream. Median radium-226 concentrations slightly exceed both the livestock watering and irrigation criteria and the New Mexico Water Supply Regulations standard for domestic water supply. The maximum radium-226 concentration also exceeds the New Mexico Ground Water Regulations standard for protection of ground waters for domestic water supply use. While radium-226 readily becomes adsorbed onto sediment or is co-precipitated and thus through these mechanisms tends to become deposited on stream bottoms, the radium-226 associated with sediments may also be later entrained and transported downstream by runoff or dewatering effluents.

While minewaters are not known to be used for irrigation in the Ambrosia Lake mining district, the use of minewaters for irrigation in the Church Rock district indicates that potential for such use exists. Molybdenum levels are normally more than a magnitude higher than the criterion recommended by Vleck and Lindsay (1977) to prevent excessive plant uptake of molybdenum. Further, while molybdenum levels normally meet the considerably higher New Mexico Ground Water Regulations standard for protection of ground water for irrigation use, the maximum measured molybdenum level even exceeds that less restrictive standard by a factor of three. Molybdenum like selenium remains in solution.

Concentrations of other constituents shown on the table raise further concerns about the use of treated minewaters in the Ambrosia Lake mining district. Total dissolved solids and sulfate concentrations normally exceed the New Mexico Ground Water Regulations standard for protection of ground waters for irrigation and domestic water supply use. Arsenic meets the livestock watering criterion, but the

TABLE 9.9 Comparison of Total Concentrations in Minewater Discharges in the Ambrosia Lake Mining District with Water Use Criteria and Standards.

CONSTITUENT	MINEWATER CONCENTRATIONS: Median	MINEWATER CONCENTRATIONS: Maximum	USE CRITERIA AND STANDARDS: Livestock Watering (NAS/NAE)	Irrigation (NAS/NAE)	Irrigation (The Molybdenum Project)	Irrigation (NM Ground Water Regulations)	Domestic Water Supply (NM Water Supply Regulations)	Domestic Water Supply (NM Ground Water Regulations)
	mg/l							
TDS	1,610	2,615	3,000			1,000		1,000
SO_4	755	1,370				600		600
As	0.011	0.20	0.2	0.10		0.1	0.05	0.1
Ba	0.21	1.7				1.0	1.	1.0
Mo	0.80	3.2			0.020	1.0		
Se	0.09	1.0	0.05	0.02		0.05	0.01	0.05
U natural	1.56	3.0				5.0		5.0
V	0.029	0.29	0.1	0.10				
	pCi/l							
Gross Alpha[a]	635	1,760	15				15	
Ra-226[b]	6.4	200	5	5			5	30

NOTE: Information on the sources of the use criteria and standards is found in Table 9.1.

[a]The gross alpha particle activity criteria exclude alpha activity due to natural uranium. Therefore, while the measured concentrations apparently are exceedances, the median and maximum natural uranium concentrations account for 1,060 and 2,030 pCi/l, respectively.

[b][illegible] 226 [illegible] 228

maximum arsenic level exceeds its irrigation criterion and standard and its domestic water supply standards. While barium levels normally meet the New Mexico Water Supply Regulations standard for domestic water supply and the New Mexico Ground Water Regulations standard for protection of ground waters for irrigation and domestic water supply use, the maximum barium level exceeds these standards. In a similar manner, vanadium levels normally meet and the maximum level exceeds livestock watering and irrigation criteria.

Gross alpha particle activity levels, which exceed the numeric levels of both the livestock watering criterion and the New Mexico Water Supply Regulations standard for domestic water supply, are accounted for by the alpha activity of natural uranium and thus are not exceedances as the criterion and the standard do not include alpha activity due to natural uranium. There is actually a large disparity between the calculated natural uranium alpha activity and the lower measured gross alpha activity levels as the median and maximum alpha activity levels for uranium are 1,060 and 2,030 pCi/l, respectively. Such differences, though, are common as a result of the difficulties of measuring gross alpha activity.

In the Church Rock mining district, the treated minewater constituents of greatest concern in relation to water uses are selenium and radium-226 (Table 9.10). Selenium normally exceeds criteria and standards established for livestock watering, irrigation, and domestic water supply. Maximum radium-226 concentrations exceed livestock watering and irrigation criteria and domestic water supply standards.

Of lesser concern in the Church Rock district are barium and molybdenum. Barium is normally below its New Mexico Ground Water Regulations standard for protection of ground waters irrigation and domestic water supply, but the maximum observed concentration was slightly higher than twice the standard of 1.0 mg/l. Molybdenum levels are normally less than the irrigation criterion recommended by Vleck and Lindsay (1977) and even the maximum level is only about one-half the New Mexico Ground Water Regulations standard for protection of ground waters for irrigation use. The irrigation criterion, however, is exceeded by the maximum observed level. While the maximum measured total dissolved solids concentration of 1,190 mg/l exceeds the New Mexico Ground Water Regulations standard for protection of ground waters for irrigation and domestic water supply use, concentrations are normally less than half the standard.

Gross alpha particle activity exceeds the numeric level of both the livestock watering criterion and the New Mexico Water Supply Regulations standard for domestic use since the criterion and the standard do not include alpha activity due to natural uranium, these levels are not exceedances. The median and maximum natural uranium concentrations are equivalent to 724 and 1,220 pCi/l of alpha activity, respectively. The differences between gross alpha activity and the calculated alpha activity due to natural uranium are attributable to the difficulties of measuring accurate gross alpha activity levels accurately.

In summary, comparisons of treated minewater quality with criteria and standards raises concern about the suitability of these waters for livestock watering, irrigation, and domestic water supply uses. Treated minewaters in the Ambrosia Lake district are poorer in quality and less suitable for these uses than those in the Church Rock district (Table 9.11). Overall, the major constituents affecting the suitability of treated minewaters are selenium, molybdenum, radium-226, total dissolved solids, and sulfate. Of these five, total dissolved solids and sulfate are the least important, as these waters are not known to be used as domestic water

TABLE 9.1[illegible] Comparison of Total Concentations of Minewater [illegible]harges in the Church Rock Mining District with W[illegible] Use Criteria and Standards.

CONSTITUENT	MINEWATER CONCENTRATION		USE CRITERIA AND STANDARDS					
			Livestock Watering	Irrigation			Domestic Water Supply	
	Median	Maximum	(NAS/NAE)	(NAS/NAE)	(The Molybdenum Project	(NM Ground Water Regulations)	(NM Water Supply Regulations)	(NM Ground Water Regulations)
	mg/l							
TDS	452	1,190	3,000			1,000		1,000
SO_4	136	600				600		600
As	<0.005	0.02	0.2			0.1	0.05	0.1
Ba	0.413	2.1				1.0	1.	1.0
Mo	0.01	0.6			0.020	1.0		
Se	0.042	0.3	0.05	0.02		0.05	0.01	0.05
U-natural	1.07	1.8				5.0		5.0
V	0.012	0.07	0.1	0.10				
	pCi/l							
Gross Alpha[a]	440	1,200	15				15	
Ra-226[b]	2.0	89	5	5			5	30

NOTE: Information on the sources of the use criteria and standards is found in Table 9.1.

[a]The gross alpha particle activity criteria exclude alpha activity due to natural uranium. Therefore, while the measured concentrations apparently are exceedance, the median and maximum natural uranium concentrations account for 724 and 1,220 pCi/l, respectively.

TABLE 9.11. Constitutents of Treated Minewaters and Affected Water Uses. Major constituents affecting water uses are indicated by M; secondary constituents by S.

Constituent	AMBROSIA LAKE MINING DISTRICT			CHURCH ROCK MINING DISTRICT		
	Livestock Watering	Irrigation	Domestic Water Supply	Livestock Watering	Irrigation	Domestic Water Supply
TDS		M	M		S	S
SO_4		M	M			
As		S	S			
Ba		S	S		S	S
Mo		M			S	S
Se	M	M	M	M	M	M
V	S	S				
Ra-226	M	M	M	S	S	S

NOTE: A constituent affecting a water use is considered major if the median concentration exceeds the most sensitive criterion or standard given in Table 9.1 for a specific use (i.e., measured levels normally exceed the criterion). A constituent is considered secondary if the median meets, but the maximum exceeds the most sensitive criterion or standard for a specific use (i.e., while measured levels normally meet the criterion, exceedances are found).

supplies or, in the Ambrosia Lake district where total dissolved solids concentrations are higher, for irrigation. Further, a compliance evaluation of total dissolved solids and sulfate in relation to irrigation use would need to consider individual ions, soils, crops, and acceptable yields. As mentioned earlier, radium-226 decreases as waters flow downstream from adsorption and co-precipitation and deposition, but may be resuspended. Selenium and molybdenum, however, remain soluble and thus continue to affect water use downstream as well as at the point of discharge.

Most radionuclides in treated minewaters are well below the maximum permissible concentrations (MPCs) for releases to unrestricted areas except for radium-226 (Table 9.12). While the MPCs apply only to state-licensed facilities and not to treated minewaters, here again MPCs serve as a useful basis for comparison. Radium-226 concentrations are normally below its MPC, but maximum levels exceed the MPC by almost three and seven times in the Church Rock and Ambrosia Lake mining districts, respectively. The maximum levels reflect poor operation of treatment systems. The only other radionuclide present in significant amounts in relation to its MPC is lead-210 in the Ambrosia Lake district. The median and maximum measured concentrations are 1/7 and 1/3 the MPC, respectively. Both radium-226 and lead-210 are usually lost from by becoming sediment-bound and deposited on stream bottoms, but may later be resuspended.

Animals exposed to Puerco River water tend to have higher concentrations of radionuclides in their tissues than control animals (Ruttenber and others, 1980). Evidence suggests that observed radionuclide concentrations have resulted from prolonged ingestion of contaminants predominantly derived from mine dewatering effluents and native soils. A separate EID study (Lapham and Millard, 1983) is intended to examine livestock throughout the Grants Mineral Belt and to quantify the risk to people who eat these animals.

While no current health standard for uranium was exceeded in treated minewaters, recent data suggest that chemical and radiological toxicities for uranium have been substantially underestimated. The New Mexico Ground Water Regulations standard of 5.0 mg/l was established for chemical toxicity, and the MPC for releases to unrestricted areas, equivalent to 44.3 mg/l, is based on radiotoxicity. In contrast, suggested maximum daily limits for potable water, developed from recent data by the U.S. Environmental Protection Agency (1983), are 0.21 mg/l and 0.015 mg/l based on chemical toxicity and radiotoxicity, respectively. If these more stringent limits are used for comparison, virtually none of the effluent affected waters would be considered suitable for potable water without further treatment.

9.6 IMPACT OF MINEWATER DISCHARGES ON GROUND WATER QUALITY

Dewatering effluents have infilterated shallow alluvial aquifers to such an extent that ground waters along San Mateo Creek downstream from the Ambrosia Lake mining district to the Otero well cluster and in localized areas along the Puerco River downstream from the Church Rock mining district now have a strong chemical resemblance to treated minewaters. Comparison of mean values for five wells along San Mateo Creek and two wells on the Puerco River determined to be affected by minewaters with use criteria and standards indicates that only molybdenum, selenium, and perhaps gross alpha are currently found in high enough concentrations to raise concerns about the suitability of shallow ground waters for livestock watering, irrigation, and domestic water supply uses (Table 9.13). Concentrations of other constituents are well below use criteria and standards.

TABLE 9.12. Comparison of Total Radioactivity in Minewater Discharges with Maximum Permissible Concentrations for Releases to Unrestricted Areas. All concentrations in pCi/l.

RADIONUCLIDES	AMBROSIA LAKE MINING DISTRICT		CHURCH ROCK MINING DISTRICT		MAXIMUM PERMISSIBLE CONCENTRATION[a]
	Median	Maximum	Median	Maximum	
Pb-210	14 ± 5	33 ± 6	---	10 ± 2[b]	100
Po-210	1.1 ± 0.4	14 ± 2	9.8 ± 7.4	15 ± 5	700
Ra-226	6.4 ± 1.2	200 ± 10	2.0 ± 0.2	89 ± 5	30
Ra-228	0 ± 2	0 ± 2	---	0 ± 2[b]	30
Th-228	<0.1	<0.3	---	<0.2[b]	7,000
Th-230	0.7 ± 0.2	4.0 ± 0.5	---	3.9 ± 0.5[b]	2,000
Th-232	<0.1	<0.1	---	<0.2[b]	2,000
U-natural[c]	1,060	2,030	724	1,220	30,000

[a] Maximum permissible concentrations are from Table II of Appendix A to Part 4 of the New Mexico Radiation Regulations (NM EID, 1980). The concentrations are not applicable to treated minewaters and are used only for comparison.

[b] Only two samples were analyzed for this radionuclide in the Church Rock mining district.

[c] Uranium radioactivity was calculated from total concentrations in mg/l by using the conversion facor, 1.0 mg/l equals 677 pCi/l.

TABLE 9.13. Mean Concentrations of Ground Water Constituents Exceeding Use Criteria and Standards.

WELL	MOLYBDENUM Mean Concentrations (mg/l)	MOLYBDENUM Affected Use	SELENIUM Mean Concentrations (mg/l)	SELENIUM Affected Use	GROSS ALPHA Mean Concentrations (pCi/l)	GROSS ALPHA Affected Use
San Mateo Creek						
SAN-1			0.018	DWS	184 ± 38	LW, DWS
SAN-2			0.018	DWS	209 ± 69	LW, DWS
OTE-1	0.381	IRR	0.080	LW, IRR, DWS		
OTE-2	0.261	IRR	0.072	LW, IRR, DWS		
OTE-4			0.102	LW, IRR, DWS		
Puerco River						
CON-3	0.170	IRR	0.011	DWS		

NOTE: The following use criteria and standards were used in preparing the table:

LW (livestock watering)

Se	0.05 mg/l	NAS/NAE (1972)
Gross alpha	15 pCi/l	NAS/NAE (1972)

IRR (irrigation)

Mo	0.150 mg/l	The Molybdenum Project (Vleck and Lindsay, 1977)
Se	0.02 mg/l	NAS/NAE (1972)

DWS (domestic water supply)

Se	0.01 mg/l)	New Mexico Water Supply Regulations (NM EIB, 1977)
Gross alpha	15 pCi/l (except for uranium and radon)	New Mexico Water Supply Regulations (NM EIB, 1977)

Selenium is the major constituent affecting the suitability of ground water for present and future use. The most sensitive use is domestic water supply; the least sensitive, livestock watering. Selenium concentrations in all five wells along San Mateo Creek and in one of the two wells (CON-3) on the Puerco River exceed the standard for public water supplies in the New Mexico Water Supply Regulations. The mean for CON-3, though, is essentially at the level of the standard. In addition, the three wells located farthest downstream on the San Mateo have selenium concentrations well above use criteria and thus are not suitable for livestock watering and irrigation. The molybdenum criterion for irrigation is exceeded at two wells in the Otero cluster along San Mateo Creek and at CON-3 on the Puerco River.

Gross alpha particle activity is generally elevated in ground waters influenced by dewatering effluents, but this increase is usually the result of natural uranium and thus does not constitute an exceedance of the livestock watering criterion and public water supply standard of 15 pCi/l. Only SAN-1 and SAN-2 had excess gross alpha activities of 34 and 39 pCi/l, respectively, not accounted for by natural uranium levels. Because of the difficulties involved in measuring gross alpha particle activity accurately and resulting errors associated with such measurements, these excess levels may be artifacts.

Comparison of ground water quality with use criteria and standards raises definite concerns about shallow alluvial aquifers along San Mateo Creek. The suitability of these ground waters for future use has already been affected. Unfortunately, sufficient data are not available to examine trends and to make predictions on future water quality.

Conclusions on ground waters along the Rio Puerco are not so clear-cut. The alluvium along the Rio Puerco is less permeable than along San Mateo Creek with the results that affected areas are more localized. Further, effects of the UNC tailings spills in local areas on the shallow aquifer has obscured possible effects related to dewatering. The levels of selenium and molybdenum, however, in CON-3, while lower than levels in wells along San Mateo Creek, indicate that there is a potential for sufficient degradation of ground water along the Puerco River to affect future water uses.

No current health standard for uranium is exceeded in alluvial ground waters. If the more stringent suggested limits discussed in section 9.5 are used for comparison, however, virtually none of the minewater affected ground waters would be suitable for potable water without further treatment. Because elevated levels of uranium may persist in alluvial aquifers for a decades, this treatment would have to be sustained for long period of time.

X. LEGAL AND REGULATORY MECHANISMS

Uranium mine operations in New Mexico are subject or potentially subject to a number of federal and state laws and regulations. No single statute addresses all significant water quality impacts resulting from uranium mining. Therefore, in order to deal with the major water pollution problems discussed in this report, the full range of currently and potentially applicable laws and regulations is evaluated in order to determine the most effective means of control.

Applicable water pollution control statutes are the federal Clean Water Act and the New Mexico Water Quality Act. Other statutes that bear less directly on water quality, but are relevant to the overall effort to protect water resources are the New Mexico Radiation Protection Act, the New Mexico Abandoned Mine Reclamation Act, the federal Resource Conservation and Recovery Act, and the federal Comprehensive Environmental Response, Compensation and Liability Act.

10.1. CLEAN WATER ACT

The Clean Water Act is the cornerstone of federal water pollution control programs. The objective of the Act as stated in Section 101(a) is "... to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Among the national goals established by the Act to achieve this objective are elimination of the discharge of pollutants into navigable waters and prohibition of the discharge of toxic pollutants in toxic amounts (Sections 101(a)(1) and (3)).

Section 402 of the Act establishes the National Pollutant Discharge Elimination System (NPDES), to regulate discharges of pollutants into navigable waters through a permit program. Under Section 502(7) "navigable waters" are defined as "waters of the United States, including the territorial seas." The courts have broadly construed "navigable waters" to mean not only perennial rivers but also their tributaries, including intermittent streams flowing through normally dry arroyos. NPDES permits for discharges in New Mexico are issued by the EPA Region VI office in Dallas, Texas.

To implement the NPDES permit program, the EPA establishes effluent limitation guidelines for various categories of discharges. These serve as a basis for effluent limitations in specific NPDES permits. The effluent limitations guidelines specify both the pollutants and the allowable discharge concentrations or loads for a type of discharge.

Under the program, uranium mines are classed as part of the ore mining and dressing point source category. Effluent limitation guidelines, published in 40 CFR Part 440, have been established for the following constitutents of uranium mine discharges:

- total suspended solids
- chemical oxygen demand
- uranium
- zinc
- total radium-226
- dissolved radium-226
- pH

While effluent limitation guidelines normally serve as the permit conditions, NPDES permits can be made more stringent than the guidelines as a consequence either of a case-specific analysis by the EPA or of more stringent permit conditions imposed through state certification. Section 401 of the Act requires the EPA to include effluent limitations, other limitations, and monitoring requirements certified by a state as necessary to meet Clean Water Act requirements and state law, regulations, and standards in a permit. In New Mexico, NPDES permits are certified by the EID as part of its responsibilites delegated by the New Mexico Water Quality Control Commission (WQCC). As a result of state certification, NPDES permits for uranium mines in New Mexico include monitoring and reporting requirements, but do not specify numeric limitations, for the following parameters:

barium
manganese
molybdenum
selenium
vanadium
lead-210
polonium-210

NPDES permit conditions for uranium minewater discharges in the Grants Mineral Belt are summarized in Table 10.1. The NPDES permit for Gulf Mineral Resources/Mt. Taylor does not include all the normal monitoring and reporting requirements because the omitted parameters are being regulated under the state Ground Water Regulations.

In practice, the NPDES permit program has not proved to be an effective means to regulate minewater discharges. Almost all NPDES permits issued to uranium mines in New Mexico have been legally challenged by the mine operators. Until these cases are finally resolved by the courts, NPDES regulations preclude EPA from taking enforcement action against the contesting permittees.

The mine operators have asserted that the EPA lacks jurisdiction because they are discharging into ephemeral streams which, they contend, are not "navigable waters" within the meaning of the Clean Water Act. This jurisdictional challenge has been rejected by every court decision thus far. In fact, in June, 1985, the U.S. Court of Appeals for the Tenth Circuit upheld an EPA administrative ruling affecting the Homestake Mining Company mines and the Kerr-McGee (Quivira Mining Company) Ambrosia Lake and Lee mines. In the August 5, 1983, order, EPA ruled that San Mateo Creek and Arroyo del Puerto can be considered waters of the United States that are subject to EPA regulation because a surface connection can exist between them and navigable waters during intense rainfalls. On January 13, 1986 the U.S. Supreme Court announced it would not review the Court of Appeals decision, thus indirectly upholding the decision. The Homestake Mining Company permit was stayed, and thus remained unenforceable, from 1972 through 1985.

10.2. NEW MEXICO WATER QUALITY ACT

In 1967 the New Mexico Legislature enacted the Water Quality Act. This Act created the WQCC and authorized the Commission to "adopt water quality standards as a guide to water pollution control" and also "adopt, promulgate and publish regulations to prevent or abate water pollution in the state." The Act defines water to include "water situated wholly or partly within or bordering upon the state,

TABLE 10 1 NPDES Permit Conditions for Uranium Minewater Discharges. An asterisk indicates that while the permit does not specify a numeric limitation, monitoring and reporting are required.

URANIUM MINEWATER DISCHARGE (NPDES PERMIT NUMBER)	PERMIT CONDITION TIME FRAME	Flow (mgd)	Temperature (°F)	TSS (mg/l)	COD (mg/l)	U-total (mg/l)	Zn-total (mg/l)	Ra-226 (pCi/l) - total	- dissolved	Ba (mg/l)	Mn (mg/l)	Mo-total (mg/l)	Se-total (mg/l)	V-total (mg/l)	Pb-210 (pCi/l)	Po-210 (pCi/l)	pH Range	TDS (kg/day-lb/day)	BIOMONITORING
Ambrosia Lake Mining District																			
Gulf Mineral Resources/Mt. Taylor	Daily Ave.	*		20	100	2.0	0.5	10	3			*	*	*			6.0-		No
(NM0028100)	Daily Max.	*	*	30	200	4.0	1.0	30	10			*	*	*			9.0		
Homestake Mining Company[1]	Daily Ave.	*		20	100	2.0	0.5	10	3			*	*	*	*	*	6.6-		
(NM0020389)	Daily Max.	*	*	30	200	4.0	1.0	30	10			*	*	*	*	*	8.6		No
Kerr-McGee (Quivira)/Ambrosia Lake[1]	Daily Ave.	*		20	100	2.0	0.5	10	3	*	*	*	*	*	*	*	6.0-		Yes
(NM0020532)	Daily Max.	*	*	30	200	4.0	1.0	30	10	*	*	*	*	*	*	*	9.0		Yes
Kerr-McGee (Quivira)/Lee Mine[1]	Daily Ave.	*	*	20	100	2.0	0.5	10.0	3.0	*	*	*	*	*	*	*	6.0-		Yes
(NM0028207)	Daily Max.	*	*	30	200	4.0	1.0	30.0	10.0	*	*	*	*	*	*	*	9.0		
Church Rock Mining District																			
Kerr-McGee (Quivira)/Church Rock	Daily Ave.	*		20	100	2.0	0.5	10	3	*	*	*	*	*	*	*	6.0-	*	Yes
(NM002524)	Daily Max.	*	*	30	200	4.0	1.0	30	10	*	*	*	*	*	*	*	9.0-	*	Yes
United Nuclear Corp./NE Church Rock Mine	Daily Ave.	*		20	100	4.0	1.0	10	*	*	*	*	*	*	*	*	6.0-	909	Yes
(NM0020401)	Daily Max.	*	*	30	200	4.0	1.0	30	10	*	*	*	*	*	*	*	9.0-	2,000	No

TABLE 10.1 (Continued)

URANIUM MINEWATER DISCHARGE (NPDES PERMIT NUMBER)	PERMIT CONDITION TIME FRAME	Flow (mgd)	Temperature (°F)	TSS (mg/l)	COD (mg/l)	U-total (mg/l)	Zn-total (mg/l)	Ra-226 (pCi/l) - total	- dissolved	Ba (mg/l)	Mn (mg/l)	Mo-total (mg/l)	Se-total (mg/l)	V-total (mg/l)	Pb-210 (pCi/l)	Po-210 (pCi/l)	pH RANGE	TDS (kg/day-lb/day)	BIOMONITORING
United Nuclear Corp./Old Church Rock Mine	Daily Ave.	*		20	100	2.0	0.5	10	3			*	*	*			6.0-	*	No
(NM0028550)	Daily Max.	*	*	30	200	4.0	1.0	30	10			*	*	*			9.0		
Other Mining Areas																			
Bokum Resources	Daily Ave.	*		20	100	2	0.5	10	3			*	*	*	*	*	6.8-		
(NM002815)	Daily Max.	*	*	30	200	4	1.0	30	10			*	*	*	*	*	8.6		Yes
Kerr-McGee (Quivira)/Marquez Mine	Daily Ave.	*		20	100	2.0	0.5	10	3	*	*	*	*	*	*	*	6.0-		
(NM0028754)	Daily Max.	*	*	30	200	4.0	1.0	30	10	*	*	*	*	*	*	*	9.0		No
Kerr-McGee (Quivira)/Rio Puerco	Daily Ave.	*		20	100	2	*	10	3	*	*	*	*	*	*	*	6.0-		Yes
NM0028169)	Daily Max.	*	*	30	200	4	*	30	10	*	*	*	*	*	*	*	9.0		
Phillips Uranium Corp./Nose Rock Mine 1, 2	Daily Ave	*		20	100	2.0	0.5	10	3	*	*	*	*	*	*	*	6.6-		
(NM0028274)	Daily Max	*	*	30	200	4.0	1.0	30	10	*	*	*	*	*	*	*	8.6-	*	No

[1] Permit is under ajudication.
[2] Per mit also includes monitoring and reporting requirements for daily average and daily maximum concentrations of alkalinity, sulfate, total aluminum, fluoride, and phenols.

whether surface or subsurface, public or private except private waters that do not combine with other surface or subsurface water."

The WQCC has determined that the federal NPDES permit program should be the primary mechanism for controlling discharges of pollutants to surface waters in the state. Consequently, state Regulations for Discharges to Surface Waters, Part 2 of the Commission regulations (NM WQCC, 1984), include a mechanism to prevent dual regulation of NPDES permittees. Discharge limitations contained in these regulations are not applicable to an NPDES permittee unless the permittee has received written notification from the EPA of a violation and the violation has not been corrected within thirty days of receipt of the notice.

The Regulations for Discharges to Surface Waters, however, are not an effective means of regulating uranium minewater discharges even after the applicability provisions of EPA notification and non-correction of violations have been satisfied. The regulations need to be amended to include numeric discharge limitations for additional parameters. Currently, the regulations specify discharge limitations only for the following parameters:

- biochemical oxygen demand
- chemical oxygen demand
- fecal coliform bacteria
- settleable solids
- pH

Of this list, only two (chemical oxygen demand and pH) are among the seven constituents of uranium minewater discharges with NPDES effluent limitation guidelines. The state regulations do not address any of the constituents for which monitoring and reporting is being required through state NPDES certification.

In its state certification of NPDES permits for uranium minewater discharges, the EID has used the general standards, Section 1-102 of the state surface water quality standards (NM WQCC, 1985), to incorporate conditions on monitoring and reporting and, when appropriate, on salinity into the permits. The general standards apply to all surface waters of the state which are "suitable for recreation and support of desirable aquatic life presently common in New Mexico waters". Among the contaminants addressed by the general standards are toxic substances and radioactivity (sections 1-102.F. and G.). The standard for toxic substances specifies that:

> Toxic substances... shall not be present in receiving waters in concentrations which will change the ecology of receiving waters to an extent detrimental to man or other organisms of direct or indirect commercial, recreational, or aesthetic value.

Under the standard, toxic concentrations are determined by appropriate bioassay techniques or by other accepted means, which may include use of established water quality criteria. Radioactivity is to "be maintained at the lowest practical level and in no case is to exceed" the numeric maximum permissible concentrations of the New Mexico Radiation Protection Regulations (NM EID, 1980).

The applicability of the general standards to ephemeral watercourses has been challenged. The uranium mine operators contend the stream standards do not apply because the watercourses to which they discharge do not support desirable aquatic life.

The EID has used the state Ground Water Regulations, Part 3 of the WQCC regulations, to regulate uranium minewater discharges, because the discharged constituents may move into ground water downstream from the discharge point. The regulations expressly exempt constituents covered by an effective and enforceable NPDES permit in order to avoid dual state and federal regulations. The regulations may be applied, however, to those constituents of a uranium minewater not covered by the NPDES for the discharge. The regulations may also be applied to all constituents of a discharge where the NPDES permit is stayed because of a legal challenge and thus is neither effective nor enforceable. Nevertheless, the Ground Water Regulations are designed specifically to protect ground water quality and the regulatory design places limitations on the effectiveness of these regulations for protecting surface water quality.

The state Ground Water Regulations establish numeric standards for the protection of ground water quality for present and potential use as agricultural and domestic water supply. The regulations require that a discharger demonstrate in a discharge plan that the discharger will not cause these standards to be violated in ground water at any place of present or foreseeable future use. Where ground water quality already exceeds a numeric standard, the ambient concentration of the constituent becomes the standard.

The design of the Ground Water Regulations makes the standards a measure of ground water quality and not discharge limitations. If a discharge plan can demonstrate that physio-chemical conditions will result in a constituent meeting its standard at any place of present or foreseeable future use of ground water, a discharger may release effluents with concentrations of a constituent in excess of its standard and still comply with the regulations.

The Ground Water Regulations have been used to regulate minewater discharges to surface watercourses at the Phillips Uranium Corporation Nose Rock mine and the Kerr-McGee Corporation (Quivira Mining Company) Lee mine because the NPDES permits were stayed because of legal challenges. In both cases the mine operators elected to comply with regulatory requirements by specifying that the mine dewatering effluents should meet the ground water standards at the point of discharge. The discussion in Chapter 8 of existing degradation of ground water by mine dewatering effluents and of physico-chemical attenuation mechanisms make it evident that dewatering effluents of much poorer quality than the ground water standards would still not result in violations of the standards for most constituents at any place of present or foreseeable future withdrawal. The exceptions are those constituents, such as selenium, which are not reduced in concentration by attenuation mechanisms.

With regard to the regulation of mine uranium waste piles, the regulatory provision of greatest potential significance is Section 2-201 of the Regulations for Discharges to Surface Waters. This section, titled 'Disposal of Refuse', states:

> No person shall dispose of any refuse into a watercourse or in a location and manner where there is a reasonable probability that the refuse will be moved into a natural watercourse by leaching or otherwise.

Under Section 1-101.00 of the WQCC regulations, "refuse" includes "all unwholesome material". There is precedent for defining mine and mill tailings as refuse. EID has used this regulatory provision to require removal of spilled copper tailings and molybdenum tailings from watercourses. This provision should also cover pond treatment sludges, which have high levels of radium-226.

The language of Section 2-201 clearly negates any argument that the refuse must have actually entered a watercourse before a violation occurs. The EID may require corrective action where there is a definitive likelihood that refuse will enter the watercourse at some future time and such action may be taken where the refuse is mine wastes, as well as in the case of other "unwholesome materials".

Leachate that results from the direct natural infiltration of precipitation through uranium mine wastes may be subject to regulation by the Ground Water Regulations if a hazard to public health exists. Results of leaching tests conducted for this study, however, suggest that the leachate would not be hazardous to public health and thus would be exempted from the discharge plan requirement.

10.3. NEW MEXICO RADIATION PROTECTION ACT

The New Mexico Radiation Protection Act was passed by the New Mexico Legislature in 1971. The Act empowers the New Mexico Environmental Improvement Board (EIB) to develop regulations for governing the health and environmental aspects of radiation. It authorizes regulation of all persons who receive, possess, use, transfer, or acquire any source of radiation, except where regulated by another agency or where the source is specifically exempted from these regulations.

The Radiation Protection Regulations promulgated by the Board (NM EID, 1980) establish rules for the transportation storage, handling, and disposal of a variety of radioactive materials. Among the materials licensed are the "wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content" (Section 1-102.G.). Wastes produced by milling (i.e., mill tailings) or by ion-exchange recovery facilities are thus covered by the regulations.

Uranium mining wastes (i.e., mine spoils piles), on the other hand, are not covered by the Radiation Protection Regulations. In fact, Section 3-110.B. specifically exempts "unrefined and unprocessed ore" from regulation. Nonetheless, this exemption is not required by the New Mexico Radiation Protection Act. The Act merely provides that the Act "shall not apply to mining [or] extraction of radioactive ores or uranium concentrates that are regulated by the United States Bureau of Mines or any federal or state agency having authority unless the authority is ceded by such agency to the board" (Section 74-3-10.c. NMSA 1978 [emphasis added]). To date, no federal or state agency regulates mine wastes in New Mexico. Consequently, the EIB is free to regulate mine wastes, should the EIB see fit to amend its regulations accordingly.

10.4. NEW MEXICO ABANDONED MINE RECLAMATION ACT

The New Mexico Abandoned Mine Reclamation Act establishes a state program to promote the reclamation of mined areas pursuant to Title 4 of the federal Surface Mining Control and Reclamation Act. To qualify, the mined areas must have been left without adequate reclamation prior to the enactment of the federal statute.

Further, in their present, unreclaimed state, the mined areas must continue to substantially degrade the quality of the environment, prevent or damage the beneficial use of land or water resources, or endanger the health or safety of the public. Funds received by New Mexico pursuant to Title 4 of the federal statute are placed in the Abandoned Mine Reclamation Fund, a special purpose fund created by the Abandoned Mine Reclamation Act.

While both state and federal acts have the primary purpose of providing for reclamation of coal mines, both acts do authorize reclamation expenditures for mines other than coal mines under certain conditions. Mirroring provisions of the federal statute, the New Mexico Abandoned Mine Reclamation Act states that "voids and open and abandoned tunnels, shafts and entryways resulting from any previous mining operation constitute a hazard to the public health or safety and... surface impacts of any underground or surface mining operations may degrade the environment" (Section 69-25B-6.B NMSA 1978 [emphasis added]). Upon prior approval by the Governor and the United States Secretary of the Interior, the director of the Mining and Minerals Division of the New Mexico Energy and Minerals Department is authorized to use the Abandoned Mine Reclamation Fund to correct structural and physical hazards and to reclaim surface impacts that could endanger life and property, constitute a hazard to public health and safety, or degrade the environment. Thus, the Abandoned Mine Reclamation Act allows expenditures of the Abandoned Mine Reclamation Fund for non-coal-mining reclamation, including uranium mine reclamation. It should be noted that the federal statute only allows the Secretary of the Interior to approve non-coal-mining reclamation where a request is made by the governor of a state and all coal-related reclamation has been completed in the state except when the requested non-coal-mining reclamation is related to the protection of public health and safety.

10.5. RESOURCE CONSERVATION AND RECOVERY ACT

A potentially significant statute for the regulation of solid wastes and sludges generated at uranium mines, is the Resource Conservation and Recovery Act (RCRA). The 1976 passage of RCRA by the U.S. Congress established a comprehensive framework for the management of municipal solid wastes and hazardous wastes. For this assessment, the most relevant feature of the Act is the Subtitle C program, which governs hazardous waste management. The most significant aspect of Subtitle C is an elaborate hazardous waste management program which guides the treatment, storage, and disposal of hazardous waste from "cradle to grave". This program has been delegated to the EID by the EPA and is governed by the New Mexico Hazardous Waste Management Regulations (NM EIB, 1984), which are equivalent to the RCRA regulations promulgated by the EPA. Under the memorandum of understanding between the EPA and the EID, the state regulations must be revised to conform when federal RCRA regulations are revised by the EPA.

In 1981 the U.S. Congress amended RCRA so as to suspend RCRA regulation of mine wastes (including uranium mine wastes) pending completion of a study by the EPA to determine whether mine wastes should be dealt with as other "hazardous wastes" are under RCRA. That EPA study (U.S. EPA, 1985) was recently submitted to Congress with preliminary recommendations on RCRA regulation of mining wastes. A recommendation whether to regulate uranium mine wastes has not been reached by EPA. The Agency is concerned that radioactive wastes may pose a threat to human health and the environment, but it does not have enough information to conclude that they do. EPA will continue to gather information to determine whether these wastes should be regulated by RCRA.

In the event that the EPA concludes that mine wastes should be covered by RCRA hazardous waste management regulations, some pre-1981 EPA actions suggest what may be expected from the EPA in regard to uranium mine waste regulation. In 1978 the EPA proposed that uranium mine wastes containing radium-226 concentrations greater than 5 pCi/g be listed as "hazardous wastes" under RCRA. At the same time the EPA also proposed special waste standards for the treatment, storage, and disposal of overburden and waste rock (see 43 Fed. Reg. 58946-59028, Dec. 18, 1978).

10.6. COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), signed into law in 1980, allows the federal government to respond to threats from uncontrolled abandoned or inactive hazardous waste sites. More specifically, CERCLA is designed for the cleanup of existing or potential contamination problems resulting from improper waste disposal practices which may present an imminent and substantial danger to public health or to the environment.

The remedial measures carried out by the federal government under CERCLA are financed by the Hazardous Substance Response Trust Fund, commonly referred to as "Superfund". Most of the Trust Fund (86.2 percent) is provided by industry through taxes, with the remaining portion appropriated from general revenues.

The guiding policy for the use of the Trust Fund is provided by CERCLA itself. In cases where the responsibility for wastes causing contamination can be traced to private parties with financial resources, CERCLA requires that the financial responsibility for cleanup be placed on those companies. This requirement helps assure that the Superfund will be available to clean up as many sites as possible where no solvent responsible party can be found.

Before a site is considered for Superfund action, each site must be quantitatively evaluated for relative ranking on the National Priorities List. Factors considered in the evaluation are the following: the population at risk, the hazard potential of hazardous substances at the facility, the potential for contamination of drinking-water supplies, the potential for direct human contact, and the potential for destruction of sensitive ecosystems. The CERCLA list of hazardous constituents includes a general radiation standard which may apply to uranium mine waste. The relative rankings of many sites in the Grants Mineral Belt, however, may be low due to sparse populations in the vicinity of uranium mining areas.
CERCLA additionally provides the EPA with authority to take enforcement actions against owners of sites not on the National Priorities List in order to compel the owners to clean up the sites. Moreover, CERCLA authorizes suits by a state against a site owner to recover response costs and damages to natural resources whether or not a site is on the National Priorities Lists.

XI. RECOMMENDED ACTIONS

The analysis of water quality impacts of uranium mining presented in this report reveals three major water quality concerns that require administrative, regulatory, or court action. Comparison of the results of the regional assessment with established criteria and standards indicates that discharge of mine dewatering effluents into surface watercourses and runoff from uranium mine waste piles are major water quality concerns. In addition, the sludges generated by treatment of minewaters have high levels of radium-226 and other radionuclides; the potential for these to be introduced into watercourses is a major concern. The relationship of these water quality concerns to the various administrative, regulatory, and judicial mechanisms discussed previously is depicted in Figure 11.1. Specific recommendations are discussed below.

11.1. CONTROL OF MINE DEWATERING EFFLUENTS

11.1.1. Background

Comparison with established use criteria and standards indicates that the quality of uranium mine dewatering effluents is not consistent with the existing use of these discharged minewaters for livestock watering and irrigation, or for their potential use for domestic water supply. This conclusion applies to both Ambrosia Lake and Church Rock Mining Districts, despite significant differences in water quality between the two districts. The constituents that most often affect the suitability of the effluents are selenium, molybdenum, radium-226, sulfate, and total dissolved solids. Concentrations of arsenic, barium, and vanadium may also exceed criteria and standards (see section 9.6).

The overview of regulatory mechanisms indicates that there are three mechanisms currently available for regulation of the discharge of mine dewatering effluents into surface watercourses: the NPDES permit program, the New Mexico Regulations for Discharges to Surface Waters, and the New Mexico Ground Water Regulations. The WQCC has determined that the NPDES permit program should be the primary avenue for controlling discharges of pollutants to surface watercourses.

Of the eight constituents listed above as affecting the suitability of dewatering effluents for livestock watering, irrigation, and domestic water supply, only radium-226 is among the constituents of uranium minewater discharges with established NPDES effluent guidelines. While radium-226 is represented twice (both as total and as dissolved) among the seven constituents having NPDES effluent guidelines, the numeric effluent guidelines for radium-226 reflect radium-removal technology and may therefore not be sufficiently stringent for resultant in-stream flows to meet criteria and standards applicable to water uses in the Grants Mineral Belt. As was mentioned previously in the regulatory overview, numeric effluent guidelines may be made more stringent and the parameter coverage broadened for uranium

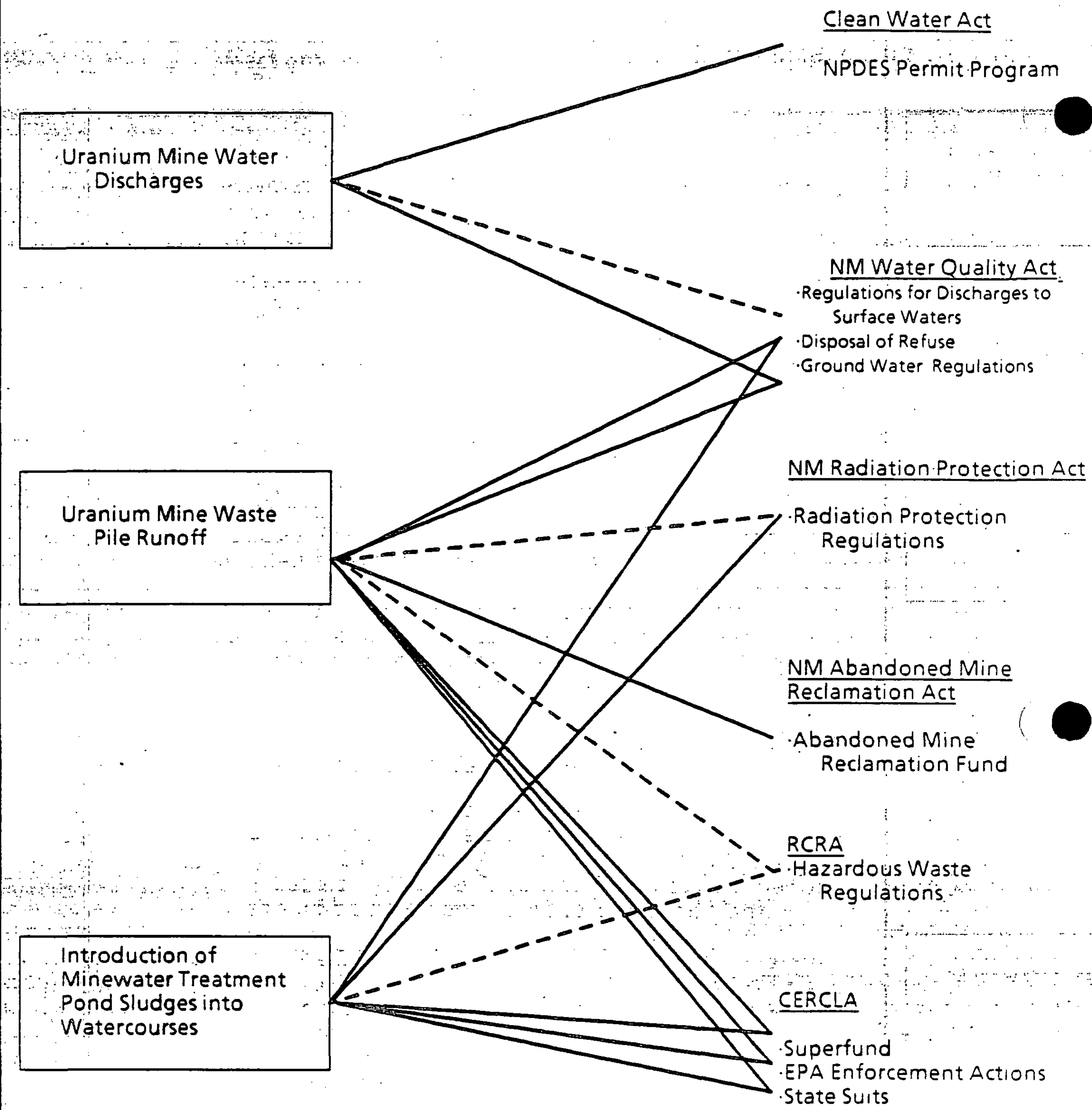


FIGURE 11.1. Legal and Regulatory Mechanisms for Controlling Major Water Quality Contaminants. Solid line indicates a currently applicable mechanism; dashed line indicates a potentially applicable mechanism.

minewater discharges in New Mexico as the result of case-specific analysis by the EPA or state certification by the EID.

Significant drawbacks currently exist, however, to the reliance on the NPDES permit program to regulate dewatering effluents. First, slightly more than one-fourth of the NPDES permits for uranium minewater discharges are under adjudication and hence, under EPA regulations, are not enforced. As noted earlier, one permit has been under adjudication for 13 years. Secondly, permits for new discharges are subject to the same legal challenge.

The New Mexico Regulations for Discharge to Surface Waters do not serve as an effective state alternative to the NPDES permit program for regulation of uranium minewater discharges for several reasons. First, a discharger with an NPDES permit is not subject to the state regulations until 30 days after the discharger has received notification of noncompliance from the EPA, provided that the discharge still remains noncompliant with permit conditions after the 30-day period. Of the 11 NPDES permits for uranium mine discharges, however, only seven are enforceable under EPA regulations. The remaining four are stayed pending resolution of adjudication. Further, the state regulations do not include discharge limitations for any trace element or radionuclide. In fact, of the seven constituents of minewater discharges for which the EPA has established numeric effluent guidelines, only two (chemical oxygen demand and pH) have discharge limitations in the state regulations. These discharge limitations are generally similar to, but not the same as, numeric effluent limitation for NPDES permits for uranium mine discharges (e.g., the state COD limitations of less than 125 mg/l compares to an NPDES daily average of 100 mg/l; and the state pH range is between 6.6 and 8.6, while the NPDES has pH ranges of 6.6 to 8.6 and 6.0 to 9.0, depending upon the specific permit).

The New Mexico Ground Water Regulations are designed to protect ground water quality for present and potential use as agricultural and domestic water supply. As was discussed earlier in this chapter, these regulations are not designed to protect surface water quality and therefore are not an effective means of regulating surface water quality.

The environmental consequences, however, of the current lack of effective regulation mine dewatering effluents are not so serious as they potentially could be. Some companies, while contesting their permits, have treated their minewaters so that discharges generally meet NPDES permit requirements. More importantly, since 1980 the uranium industry in New Mexico has experienced a major decline that is expected to continue for an indefinite period. The result is that of the 11 uranium mines with NPDES permits, seven have ceased discharging. Of the remaining four, two still have permits under adjudication. Nevertheless, the information presented in Chapters IV and VI clearly documents the impairment of water resources that occurred prior to 1980 and could resume if the industry revives while water pollution controls remain ineffective.

11.1.2. Recommendations

1. The EID should coordinate with the EPA so that new or renewal NPDES permits for uranium mine dewatering effluents in New Mexico include numeric effluent limitations for radium-226 and other parameters related to downstream uses of these waters. Factors to be considered in the development of these effluent limitations are present water uses, likelihood of future uses, and technology available for water treatment. At a minimum, the quality of the effluent should

meet the requirements specified in the "Hazardous Substances" and "Radioactivity" (1-102.G.) portions of Water Quality Standards for Interstate and Intrastate streams in New Mexico (WQCC, 1985). Such effluent limitations may be included in permits through state certification by the EID or case-specific analysis by the EPA.

2. The New Mexico Regulations for Discharges to Surface Waters should be substantially amended to serve as an effective means of regulating uranium mine dewatering effluents and other discharges to surface watercourses. Amendments should include comprehensive numeric discharge limits not only for those chemical constituents regulated by NPDES, but for other constituents necessary to protect water quality for agricultural or domestic use.

11.2. CONTROL OF RUNOFF FROM MINE WASTE PILES

11.2.1 Background

The extensive survey by Anderson (1980) provides a basis for estimating that 10 to 20 percent of all abandoned uranium mines and a few large active mines have waste piles that are eroding directly into surface drainage channels. Data developed for this report indicate that sediment carried by runoff from waste piles into surface watercourses has high levels of trace elements and radioactivity associated with it. Contaminated sediments are particularly evident in arroyos and drainage channels in close proximity to spoils piles. These sediments undergo recurring cycles of deposition on stream bottoms, resuspension, and transport further downstream. Eventually sediments from mine waste piles become so mixed and diluted with other sediments that they cannot be chemically differentiated on the basis of trace element and radioactivity levels. Nevertheless, these sediments do increase the total load of trace elements and radioactivity in affected drainages.

Moreover, turbid stream flows may be ingested by livestock. Levels of arsenic, cadmium, lead, selenium, vanadium, gross alpha particle activity, and radium-226 associated with mine waste pile runoff are not consistent with livestock watering.

Technical means for dealing with uranium mine waste piles, either by surface stabilization or by mine stope backfilling, are well known (e.g., EPA, 1973b; Maryland Department of Natural Resources 1983; New Mexico Coal Surface Mining Commission 1980; and Longmire 1985. Engineering options include backfill of abandoned mine workings with waste rock and low-grade ore; contouring waste piles to a slightly convex configuration; construction of berms upslope and downslope of the wastes to minimize runoff; and use of large boulders and waste rock to armor the contoured waste pile. Some Indian tribes and federal agencies (e.g., USDA Forest Service) do require contouring and stabilization of mine waste piles and disturbed mine sites, but those actions have affected only a few sites.

The economic impact of stabilization or removal of mine wastes is believed to be minor when prorated over the life of a mine. Relative to other uranium industry operations, the volume of potentially hazardous waste generated by uranium mines in New Mexico is quite low.

Legal mechanisms currently available for control of waste pile runoff include state regulations, the Abandoned Mine Reclamation Fund, and provisions of CERCLA. The provision in the WQCC regulations on disposal of refuse already has precedent for use as a means of requiring mine tailings stabilization. The New Mexico Ground

Water Regulations can be used to regulate leachates from mine waste piles that affect ground water quality, should a hazard to public health exist. However, the results of leaching tests conducted for this study suggest such conditions are this is unlikely.

The Abandoned Mine Reclamation Fund, while primarily intended for coal reclamation, can be used for non-coal-mining reclamation under special circumstances. Use of the fund for reclamation of uranium mine waste piles requires concurrence between the New Mexico Energy and Minerals Department, the Governor, and the U.S. Secretary of the Interior. In addition, use of the Fund is subject to federal statutory provisions that all coal-mining reclamation needs in the state have been addressed or, alternatively, that there are over-riding public health or safety considerations that justify dealing with non-coal-mining reclamation before coal-mining reclamation needs are met.

Superfund cleanup under CERCLA may potentially be useful for control of runoff from abandoned or inactive waste piles, but its availability will depend upon site-specific rankings of piles on the National Priorities List. Two other provisions of CERCLA, however, have definite potential for control of mine waste runoff. These are the authority given to the EPA to compel owners to clean up sites not on the National Priorities List, and the authorization of state suits to recover response costs and damages to natural resources.

In addition, the New Mexico Radiation Protection Regulations and RCRA are potential regulatory mechanisms for control of mine waste runoff. The former requires a decision by the EIB to amend these state regulations to extend their applicability to mine wastes. The latter requires a completion of a study by the EPA on uranium mine wastes.

11.2.2 Recommendations

1. The removal or stabilization of the largest uranium mine waste piles eroding directly into surface drainages should be pursued. Priority sites should include the Old San Mateo Mine near San Mateo Creek and the Jackpile-Paguate mine areas along the Rio Paguate. Technical criteria for stabilization or removal should be based on individual site conditions.

   a. The EID should require removal or stabilization actions based upon the provision of the WQCC regulations on Disposal of Refuse. Should the provision not be useful, the EID should then pursue reclamation through other available means. Such means include Superfund cleanup, EPA enforcement actions under CERCLA, and state-funded cleanup accompanied by state suits to recover cleanup costs and environmental damages.

   b. Where removal or stabilization cannot be accomplished through regulatory actions, the EID should consult with the Governor and the New Mexico Energy and Minerals Department on use of the Abandoned Mine Reclamation Fund for cleanup.

2. The EID should not take immediate action to regulate future uranium mine waste piles directly as it is anticipated that the EPA will present a recommendation to the U.S. Congress in 1986 on whether to control uranium mine wastes under RCRA. Should mine wastes be regulated under RCRA, it is unlikely that additional state regulations would be required.

3. Should uranium mine waste piles be excluded from RCRA regulation, the EID should recommend that the EIB amend the New Mexico Radiation Protection Regulations to extend their applicability to mine wastes.

11.3. CONTROL OF MINEWATER TREATMENT POND SLUDGES

11.3.1. Background

Minewater treatment pond sludges resulting from the settling, coagulation, and treatment of raw minewaters have high levels of radium-226 and other radionuclides. In fact, radium-226 concentrations probably average more than 200 pCi/gram. Therefore, the potential introduction of these sludges into surface watercourses through erosion is a matter of concern.

Management of sludges is widely performed, but not universal. In particular, mine operations that conduct ion-exchange removal of uranium from minewaters are usually required by New Mexico Radiation Protection Regulations to dispose of associated minewater treatment pond sludges properly. However, sludges resulting from coagulation and settling of radium-226 from raw minewaters remain unregulated.

Other legal mechanisms available for control of minewater treatment sludges are the provisions of the WQCC regulations on Disposal of Refuse and the provisions of CERCLA related to Superfund cleanup, EPA enforcement actions, and state suits for recovery of costs. In addition, as a result of the EPA uranium mine waste study, RCRA may regulate these sludges. RCRA is potentially the most effective regulatory mechanism for sludges generated in the future. Nonetheless, the state provision on Disposal of Refuse and CERCLA provisions on EPA enforcement actions and state suits appear to provide adequate means to deal with any cleanup or stabilization problems that may occur in the near future, but only on a case-specific ad hoc basis. Superfund cleanup should not be needed unless adequate provisions are not taken now to ensure proper stabilization or disposal of sludges.

11.3.2. Recommendation

The EID should rely on the same regulatory framework for minewater treatment pond sludges as for mine wastes. Therefore, EID should wait to see if RCRA will apply to uranium mine wastes, including these sludges, as RCRA regulation will probably obviate the need for additional state regulation. If such wastes are found to be exempt from RCRA regulation, the EID should recommend that the Environmental Improvement Board amend the New Mexico Radiation Protection Regulations to control these sludges fully and effectively.

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(2)

Mayerson, David, NMENV

From: LucasKamat, Susan, EMNRD
Sent: Wednesday, August 08, 2007 09:35
To: Mayerson, David, NMENV
Subject: RE: Abandoned Uranium Mine Survey Draft SOW-07-25-07 (1).doc

David:
The attached metadata document provides information on all the data sources and a description of all the column headings. (The column headings are the longer versions in the original spreadsheet I sent you - importing into ArcGIS truncated the column headings.)

ACE_EPA_NA truncated ACE_EPA_NAMLP_Survey
indicates if the mine was included in the Navajo Nation AUM assessment (Terra Graphics documents)
does not imply a site was addresses, only that it was included in the inventory
includes non-Navajo lands in the checkerboard (Eastern region)
EAUM_No MineID No from Navajo AUM Inventory - Eastern Region
NAUM_No MineID form Navajo AUM Inventory - Northern Region
Producti_1 truncated Production_ore_ST
ore production credited to mine
Producti_2 truncated Production_U3O8_lbs
yellowcake production credited to mine
Other_Agen Other agency numbers (i.e. CERCLIS No, NMED DP, USFS claim No, etc)
In the Excel spreadsheet I've broken these out into a separate column, but the shapefile doesn't have them broken out yet.
Prod_rank Production rank

The production rank is a bit tricky due to the history of uranium production. The AEC (Atomic Energy Commission) purchased all uranium ore and yellowcake before 1968. Between 1968 and 1970 both the AEC and private industry purchased yellowcake. Post-1970 all uranium production went to private industry. Therefore, production figures only reflect production reported to the AEC; the AEC receipts are public information. Almost all production post-1970 is confidential. Chenoweth & McLemore devised the production category figure to account for post 1970 production. (Theoretically, production would have been submitted to the State Mine Inspector (SMI) in their annual reports. Unfortunately, when the SMI split form MMD back in the mid-80s, they retained ownership of the SMI annual reports and they have been destroyed. Those reports have been destroyed. So the only post-1970 production numbers are in the Mine Registration Program annual reports starting in 1989. SO essentially 10 years of production numbers are missing.)

MMD estimated production rank. We sorted first by production category (a,b,c,d,e) and then by production U3O8 within each production category. Mines with no production numbers were then ranked by looking at disturbance area - assuming greater disturbance=greater production. Mines whose production was credited to other mines (i.e. Anaconda's Laguna mines, the Dog-Flea Mines, Section 25, etc) were moved up in the rankings.

I haven't done anything further with documenting sources. The methods section of the metadata document gives the best information on data sources. For example, all radiation/hazards data comes from the Anderson report, BLM inventory, AML project files of MARP files. Reclamation data comes form those same sources. Ownership data is form BLM GIS coverages, augmented by AML realty and MARP realty files. Did you have particular column you need definitive sources for? Or particular mines?

Hope this answers your questions!

Susan A. Lucas Kamat
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2007-07-20_
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From: Mayerson, David, NMENV
Sent: Wednesday, August 08, 2007 8:15 AM
To: LucasKamat, Susan, EMNRD
Subject: RE: Abandoned Uranium Mine Survey Draft SOW-07-25-07 (1).doc

Hi Susan: Could you tell me what the following fields mean in your mines database?

ACE_EPA_NA (Am I correct to presume this indicates whether the site was addressed under NAUM?)
EAUM_NO
PRODUCTI_1
PRODUCTI_2
MARP_STATU
OTHER_AGEN (Specifically, what does an entry here signify?)
PROD_RANK (I presume this means "production rank;" however the ranking doesn't appear to correspond to PRODUCTI_1 and PRODUCTI_2, so maybe I'm wrong here)

Also, you had indicated that you might work on documenting where various information comes from in your database; I was wondering if that was going forward. Thanks.

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(1)

DRAFT VERSION

June 19, 2007

NEW MEXICO ABANDONED AND INACTIVE URANIUM MINES

Mining and Minerals Division

New Mexico Energy, Minerals & Natural Resources Department

Cautionary/Disclaimers

1. **Draft version. Data is still being collected, verified and added.**

2. Production numbers are from MINES database (McLemore 2007) and only reflect production before 1970. (Production pre-1970 was reported to AEC and is public information. Production after 1970 is confidential and/or unknown.) The production categories (a, b, c, d, e, f, no) correspond to ranges of production from McLemore 2007.

3. Production rank is estimated.

4. Realty/ownership has not been verified in deeds, claims and records at county courthouses and/or BLM.

5. Locations have not been field verified with GPS coordinates.

6. Legal descriptions represent mined areas. They do not reflect total areas of disturbance. Disturbed or affected areas may lie outside of the mined area boundaries. Areas mined underground may not have any surface disturbances.

7. Reclamation approval from one agency does not mean that all hazards have been abated. (Example – There may be remaining waste piles at sites that NM MMD-AML reclaimed that require further action under MMD-MARP or NMED.)

8. The EPA/ACE/Navajo inventory represents mines were included in the Navajo Nation inventory reports (Eastern & Northern). These sites were identified as mines that could potentially affect/impact the Navajo Nation. That inventory included, in addition to Navajo tribal lands, private, state and federal lands in the checkerboard.

9. Current regulating agency is the agency or agencies that currently have a mine property under their regulatory umbrella. Potential jurisdictional agency is an agency that might have jurisdiction over a mine property based on production dates or ownership.

10. NMED could be a potential jurisdictional agency for all mines.

11. Question marks in any column represent uncertainty or further research required.

Definition of columns, for MINES spreadsheets:

a.	Mine ID	NMBGMR Mine ID
b.	County	County primary shaft or disturbance mine is located in
c.	Mining District	Uranium mining district based on NMBGMR mining districts
d.	Mine_name	Popular name of mine
e.	Aliases	Alternate mine names
f.	Township	Township(s)
g.	Range	Range(s)
h.	Section	Section(s)
i.	Quarter Section	Quarter Section(s)
j.	UTM_easting	UTM coordinate, easting
k.	UTM_northing	UTM coordinate, northing
l,	UTM_zone	UTM zone
m.	Location_assurance	Location source, from McLemore 2007
n.	Point_of_location_reference	How point was acquired, from McLemore 2007
o.	Surface_land_status	
p.	Minerals_land_status	
q.	Surface_ownership	
r.	Mineral_ownership	
s.	ACE_EPA_NAMLP_Survey	Yes, if mine was included in Navajo Nation AUM Assessment (Note: assessment included non-Indian lands in the checkerboard) No, if mine was not included in Navajo Nation AUM Assessment
t.	EAUM_No	Mine ID Navajo Nation Eastern Region AUM
u.	NAUM_No	Mine ID Navajo Nation Northern Region AUM
v.	Commodities_produced	Commodities mined/produced
	Commodities_present_not_produced	(on Mines no prod spreadsheet)
w.	Mining_methods	surface, underground and/or in situ leach
x.	Development	Mine development
y.	Depth_of_workings	Depth of workings
z.	Length_of_workings	Length of workings
aa	Year_of_initial_production	Year of first uranium production
ab	Year_of_last_production	Year of final uranium production Note: Mining was not necessarily continuous between initial and last years. See Mining_history for specific details.
ac.	Mining_history	Years of operation and operating company. In some cases, mines were inactive/idle/on standby and not producing uranium
ad.	Production_category	NMBGMR production categories e > 20 million lbs U3O8 d 2 - 20 million lbs U3O8 c 200,000 – 2 million lbs U3O8 b 20,000 – 200,000 lbs U3O8 a < 20,000 lbs U3O8 f included with another mine u production unknown no no production
ae.	Production_ore_ST	ore production in short tons (pre-1970, unless noted in Comments_on_production)
af.	Production_U3O8_lbs	yellowcake production in pounds (pre-1970, unless noted in Comments_on_production)
ag.	Comments_on_production	Comments about production, i.e. estimated, included in other mine, etc.
ah.	Disturbed_area_acres	Extent of disturbance in acres.
ai.	Disturbed_acres_source	Data source for acreage. Methods for determining acreage may not be the same across agencies.

aj. USGS Quad	
ak. Land_use	post-mining land use
al. Radiation_hazards	any known radiological measurements at the site
am. Potential_hazardous_materials	any known physical hazards like shafts, headframes, vents, foundations, debris/trash
an. Hydrology	if mine was wet or dry, pumping rate provided if known
ao. Receiving_stream	
ap. Reclamation_details	reclamation details, including dates, actions/abatement completed
aq. Rec_prim_co	company that performed reclamation activities
ar. Current_reg_agency	regulating agency that oversaw reclamation, is actively overseeing reclamation, or has permitted the mine/facility
as. Potential_reg_agency	agency that could potentially regulate site
at. MARP_status	MMD Mining Act Reclamation Program determination Permitted, Released or exempt Not exempt - mine that may fall under the program No release - mine that has not met Prior Reclamation
au. MARP_Permit_No	RE = regular existing, PR = prior reclamation
av. NMED_DP	NMED discharge permit
aw. US_EPA_CERCLIS_No	EPA CERCLIS No. (from NMED list & EPA website)
ax. AML_Anderson_Report	MMD-AML record number of Anderson Report
ay. BLM_claim_no	BLM mineral claim numbers
az. BLM_Inventory	date of BLM field visit/report in BLM AUM inventory
ba. USFS_No	USFS mineral ID number
bb. MRDS_number	USGS MRDS number
bc. NRC_No	NRC license & docket numbers
bd. MSHA No	MSHA registration number
be. Comments	record of mines from McLemore 2007 database combined
bf. References	published references form McLemore 2007
bg. Prod rank	MMD estimated production rank, based on sorting by production within production category. Mines whose production was credited to other mines were moved up in rankings (for example, Anaconda's Jackpile mines, the Dog-Flea mines).

Methods:

1. MMD started with the most recent (McLemore 2007) version of the BGMR publication Database of the uranium mines, prospects, occurrences, and mills in New Mexico, called "MINES" database. The MINES database was created for resource analysis on a section and quarter section basis. MMD analyzed the database records and combined records to create one mine per shaft/pit complex.

2. Mining history (years and company) from McLemore, Chenoweth and Anderson sources was added.

3. Disturbance area, reclamation, radiological information and hazard information from the MMD-AML Anderson report was added.

4. Disturbance area, reclamation, mining history, mining production dates and ownership/realty information from AML project files was added.

5. Disturbance area, reclamation, mining history, mining production dates and ownership/realty information from MARP prior reclamation and permit files was added.

6. Reclamation, ownership and mining history from the MRRS program files was added.

7. Reclamation status, Navajo land status and disturbance area was added from the EPA/ACE abandoned uranium mine assessments for the Northern and Eastern Navajo Nation.

8. Disturbance area, reclamation, radiological information, mining history and hazard information from the BLM uranium inventory was added.

9. Operator information form the MSHA Data Retrieval System was added.

10. Mining history information from the SMI abandoned uranium mine card file was added.

11. Ownership data from BLM surface and mineral management GIS coverages was added.

12. Mines were sorted by production (largest to smallest) with the assumption that the largest producers of uranium have the potential for the largest disturbance.

13. Data from NMED was added. CERCLIS numbers from NMED Ground Water Quality Bureau – Superfund Oversight "Uranium Mine & Mill CERCLIS Summaries" and EPA website. NMED discharge permit numbers added.

Sources:

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McLemore, V. T., Donahue, K., Krueger, C. B., Rowe, A., Ulbricht, L., Jackson, M. J., Breese, M. R., Jones, G., and Wilks, M., 2002, Database of the uranium mines, prospects, occurrences, and mills in New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open file Report 461.

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Anderson, O.J., 1981, Abandoned or inactive uranium mines in New Mexico, New Mexico Bureau of Mines and Mineral Resources, Open-File Report 148.

Inactive Uranium Mines Card File, New Mexico State Mine Inspector.

Registrations, Annual Reports and Suspension Notices, Mine Registration, Reporting and Safeguarding Program (MRRS), New Mexico Mining and Minerals Division.

Hyde/Wingate Project, Wingate Hogback Project, Grants Uranium Project Phases I to III, San Mateo Mine Project files, Abandoned Mine Land Program (AML), New Mexico Mining and Minerals Division.

Prior Reclamation and Permit files, Mining Act Reclamation Program (MARP), New Mexico Mining and Minerals Division.

Data Retrieval System, Mine Safety and Health Administration, http://www.msha.gov/drs/drshome.htm.

Bureau of Land Management Surface and Mineral Administration GIS Coverages

Envirofacts – CERCLIS Querry Form, Envionmental Protection Agency, http://www.epa.gov/enviro/html/cerclis/cerclis_query.html

New Mexico Environment Department, Ground Water Quality Bureau, Superfund Oversight Section, Uranium Mine and Mill CERCLIS Summaries

LATITUDE	LONGITUDE	UTM_EASTIN	UTM_NORTHI	UTM_ZONE	LOCATION_A	POINT_OF_L	SURFA	MIN	SURFACE_OW	MINERAL_OW	ACE_EPA_NA	EAUM_NO	NAUM_NO	MINING_MET	DEVELOPMEN	YEAR_OF_IN	YEAR_OF_LA
0.0000000000	0.0000000000	240866.0000000000	3909546.0000000000	13.0000000000	topo	literature	private	federal		Bureau of Land Management	No			surface	pit	1954.0000000000	1966.0000000000
0.0000000000	0.0000000000	240370.0000000000	3908683.0000000000	13.0000000000	topo	literature	private	private			No			surface	pit	1957.0000000000	1966.0000000000
0.0000000000	0.0000000000	245219.0000000000	3908448.0000000000	13.0000000000	topo	literature	private	federal		Bureau of Land Management	No			surface	pit	1951.0000000000	1956.0000000000
0.0000000000	0.0000000000	249023.0000000000	3907370.0000000000	13.0000000000	HM topo	literature	federal	federal	U. S. Forest Service	U. S. Forest Service	No			surface	pits	1961.0000000000	1961.0000000000
0.0000000000	0.0000000000	245503.0000000000	3908047.0000000000	13.0000000000	topo	literature	private or federal	private or federal	private or Bureau of Land Management	private or Bureau of Land Management	No			surface	vertical rim cuts	1954.0000000000	1955.0000000000
0.0000000000	0.0000000000	241102.0000000000	3914556.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management	Bureau of Land Management	Yes	300		surface	trench	1956.0000000000	1960.0000000000
0.0000000000	0.0000000000	245782.0000000000	3910453.0000000000	13.0000000000	topo	literature	private	private	Sammy & Isabel Marquez	Newmont Mining Co	No			surface	5 pits scattered throughout S 2	1958.0000000000	1958.0000000000
0.0000000000	0.0000000000	237221.0000000000	3919415.0000000000	13.0000000000	topo	literature	Indian Allotment	Indian Allotment	Navajo Allotee	Navajo Allotee	Yes	349, 350		underground	decline adit, 2 short adits, 500 ft workings	1957.0000000000	1963.0000000000
0.0000000000	0.0000000000	237047.0000000000	3919423.0000000000	13.0000000000	topo	literature	Indian Allotment	Indian Allotment	Navajo Allotee	Navajo Allotee	Yes	348		underground	adit	1957.0000000000	1961.0000000000
0.0000000000	0.0000000000	236910.0000000000	3919427.0000000000	13.0000000000	topo	literature	Indian Allotment	Indian Allotment	Navajo Allotee	Navajo Allotee	Yes	352		surface	pits	1953.0000000000	1963.0000000000
0.0000000000	0.0000000000	242700.0000000000	3912700.0000000000	13.0000000000	topo	field location	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	declines, connects to Roundy & Barbara J. No. 2 mines	1979.0000000000	1981.0000000000
0.0000000000	0.0000000000	235760.0000000000	3916200.0000000000	13.0000000000	topo	literature	state	state	State Land Office	State Land Office	Yes	347		surface	pits	1952.0000000000	1966.0000000000
0.0000000000	0.0000000000	234621.0000000000	3919268.0000000000	13.0000000000	topo	literature	private	private	Cerrillos Land Company	Newmont Mining Co	Yes	346		underground	adit	1958.0000000000	1964.0000000000
0.0000000000	0.0000000000	244240.0000000000	3911184.0000000000	13.0000000000	topo	field location	state	state	State Land Office	State Land Office	No			underground	20 degree decline, caved along its length	1961.0000000000	1963.0000000000
0.0000000000	0.0000000000	241731.0000000000	3911590.0000000000	13.0000000000	topo	field location	state	state	State Land Office	State Land Office	Yes	372		surface	pits, trenches	1952.0000000000	1964.0000000000
0.0000000000	0.0000000000	246412.0000000000	3909074.0000000000	13.0000000000	topo	literature	private	federal	Bureau of Land Management, private	Bureau of Land Management	No			surface	adits, pits	1952.0000000000	1967.0000000000
0.0000000000	0.0000000000	247680.0000000000	3904454.0000000000	13.0000000000	topo	literature	federal	federal	U. S. Forest Service	U. S. Forest Service	No			surface, underground	pits, trenches, adits	1952.0000000000	1960.0000000000
0.0000000000	0.0000000000	247380.0000000000	3905703.0000000000	13.0000000000	topo	map symbol	federal	federal	U. S. Forest Service	U. S. Forest Service	No			underground, surface	pits, adit	1952.0000000000	1958.0000000000
0.0000000000	0.0000000000	246471.0000000000	3900544.0000000000	13.0000000000	topo	center of mine complex	private	private			No			surface	pit	1952.0000000000	1976.0000000000
0.0000000000	0.0000000000	245770.0000000000	3908447.0000000000	13.0000000000	topo	literature	private	private			No			surface, underground	pits, adit	1950.0000000000	1962.0000000000
0.0000000000	0.0000000000	242816.0000000000	3913103.0000000000	13.0000000000	topo	field location	federal	federal	Bureau of Land Management	Bureau of Land Management	No			room and pillar	vertical shaft	1956.0000000000	1980.0000000000
0.0000000000	0.0000000000	243335.0000000000	3915712.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground, open stope	70 degree incline (Sec 20) - air vent for Poison Canyon Mine, 3 air shafts, 1 ai	1958.0000000000	1978.0000000000
0.0000000000	0.0000000000	243635.0000000000	3914713.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	45 degree decline	1966.0000000000	1967.0000000000
0.0000000000	0.0000000000	241563.0000000000	3914526.0000000000	13.0000000000	topo	field location	federal	federal	Bureau of Land Management	Bureau of Land Management	Yes	361		underground, stopping	6 adits, pits	1961.0000000000	1966.0000000000
0.0000000000	0.0000000000	243776.0000000000	3914251.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management		No			underground	70 degree incline, adit	1957.0000000000	1966.0000000000
0.0000000000	0.0000000000	240580.0000000000	3920095.0000000000	13.0000000000	topo	map symbol	private	private	? Homestake Mining Co	? Homestake Mining Co	No			underground	vertical shaft, used as ventilation for Cobb Section 12	1959.0000000000	1963.0000000000
0.0000000000	0.0000000000	244199.0000000000	3912841.0000000000	13.0000000000	topo	literature	private	private	Isabella O. Marquez Trust	Newmont Mining Corp	No			underground	vertical shaft and hoisting shaft	1958.0000000000	1964.0000000000
0.0000000000	0.0000000000	243350.0000000000	3912201.0000000000	13.0000000000	topo	field location	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	decline with 1 adit	1965.0000000000	1966.0000000000
0.0000000000	0.0000000000	249310.0000000000	3915417.0000000000	13.0000000000	topo	literature	private	federal		Bureau of Land Management	No			underground	vertical shaft	1959.0000000000	1962.0000000000
0.0000000000	0.0000000000	242521.0000000000	3913794.0000000000	13.0000000000	topo	field location	private	private	Isabella O. Marquez Trust	Newmont Mining Corp	No			underground	shaft, covered, plugged, and reseeded	1977.0000000000	1981.0000000000
0.0000000000	0.0000000000	238412.0000000000	3927034.0000000000	13.0000000000	topo	map symbol	private	private	??? Homestake Mining CO	??? Homestake Mining Co	Yes	1014		underground	vertical shaft, underground workings 328-454 ft deep	1959.0000000000	1965.0000000000
0.0000000000	0.0000000000	244636.0000000000	3914680.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground, open stope	2 decline shafts	1954.0000000000	1958.0000000000
0.0000000000	0.0000000000	247187.0000000000	3910277.0000000000	13.0000000000	topo	literature	federal	federal	U. S. Forest Service	U. S. Forest Service	No			underground	70 degree decline	1957.0000000000	1963.0000000000
0.0000000000	0.0000000000	243104.0000000000	3917821.0000000000	13.0000000000	topo	map symbol	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	vertical shaft with 2,000 ft drifts	1958.0000000000	1980.0000000000
0.0000000000	0.0000000000	232678.0000000000	3915724.0000000000	13.0000000000	topo	map symbol	Indian Allotment	Indian Allotment	Navajo Allotee	Navajo Allotee	Yes	334, 1010, 1027		underground, surface	2 vertical shafts, open pits, trench decline	1952.0000000000	1960.0000000000
0.0000000000	0.0000000000	230777.0000000000	3913737.0000000000	13.0000000000	topo	literature	Indian Fee (Sec 23), Indian Allotment (Sec 26)	Indian Fee (Sec 23), Indian Allotment (Sec 26)	Navajo Tribal Fee (Sec 23), Navajo Allotee (Sec 26)	Navajo Tribal Fee (Sec 23), Navajo Allotee (Sec 26)	Yes	304		surface	pit; westward extension of Haroush Mine	1957.0000000000	1960.0000000000
0.0000000000	0.0000000000	250082.0000000000	3914870.0000000000	13.0000000000	topo	map symbol	private	private	Marquez Ranch	Conoco	No			underground	shaft, production shaft, Sec 13 mined through shaft	1960.0000000000	1961.0000000000
0.0000000000	0.0000000000	243419.0000000000	3911075.0000000000	13.0000000000	topo	map symbol	private	private	Isabella O. Marquez Trust	Newmont Mining Corp	No			surface	several shallow pits and trenches	1953.0000000000	1975.0000000000
0.0000000000	0.0000000000	242100.0000000000	3921544.0000000000	13.0000000000	topo	map symbol	state	state	State Land Office	State Land Office	No			underground	vertical shaft	1957.0000000000	1960.0000000000
0.0000000000	0.0000000000	233647.0000000000	3920264.0000000000	13.0000000000	topo	literature	private	private	Berryhill Family	Berryhill Family	Yes	340		surface, underground	4 adits, pits	1952.0000000000	1966.0000000000
0.0000000000	0.0000000000	232067.0000000000	3920636.0000000000	13.0000000000	topo	literature	private	private	Berryhill Family	Berryhill Family	Yes	340		surface	pits	1955.0000000000	1958.0000000000
0.0000000000	0.0000000000	241702.0000000000	3925530.0000000000	13.0000000000	topo	map symbol	private	private	Jerry & Luann Elkins	Newmont Mining Corp	No			underground	shaft	1979.0000000000	1981.0000000000
0.0000000000	0.0000000000	249160.0000000000	3914415.0000000000	13.0000000000	topo	literature	private	private	Isabella O. Marquez Trust	Newmont Mining Corp	No			underground	10 degree decline	1954.0000000000	1971.0000000000
0.0000000000	0.0000000000	241480.0000000000	3913480.0000000000	13.0000000000	topo	field location	private	private	Elkins Real Estate, Berryhill Ranch, Ltd	Newmont Mining Corp	Yes	302		underground	shaft (plugged)	1952.0000000000	1973.0000000000
0.0000000000	0.0000000000	230837.0000000000	3927123.0000000000	13.0000000000	topo	map symbol	private	private	Unknown	unknown	Yes	358		underground	vertical shaft, vent hole	1958.0000000000	1983.0000000000
0.0000000000	0.0000000000	244743.0000000000	3914368.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	incline adit, connects to First Mine	1957.0000000000	1975.0000000000
0.0000000000	0.0000000000	241341.0000000000	3912727.0000000000	13.0000000000	topo	field location	private	private	Elkins Real Estate, Berryhill Ranch, Ltd	Newmont Mining Corp	Yes	355, 360		surface	open pits, trenches	1952.0000000000	1981.0000000000
0.0000000000	0.0000000000	243127.0000000000	3914502.0000000000	13.0000000000	topo	field location	private	private	Isabella O. Marquez Trust	Newmont Mining Corp	No			surface, underground	pits, 2 adits, Beacon Hill-Gossett used as ventilation shaft	1952.0000000000	1978.0000000000
0.0000000000	0.0000000000	240500.0000000000	3925415.0000000000	13.0000000000	topo	map symbol	private	federal	Cobb Resources	Bureau of Land Management	Yes	1013		underground	vertical shaft, connects to Dysart No. 2	1957.0000000000	1982.0000000000
0.0000000000	0.0000000000	238069.0000000000	3927226.0000000000	13.0000000000	topo	literature	federal, private	federal, private	Cobb Resources, ??? Bureau of Land Management	Cobb Resources, ??? Bureau of Land Management	Yes	359		underground	vertical shaft	[illegible]	1981.0000000000
0.0000000000	0.0000000000	243210.0000000000	3913444.0000000000	13.0000000000	topo	field location	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	shaft	1959.0000000000	1980.0000000000
0.0000000000	0.0000000000	242414.0000000000	3917060.0000000000	13.0000000000	topo	field location	private	private			Yes	371		surface, underground	shaft, connects to Piedra Triste	1952.0000000000	1981.0000000000
0.0000000000	0.0000000000	243458.0000000000	3917546.0000000000	13.0000000000	topo	literature	private	private	Isabella O. Marquez Trust	Newmont Mining Corp	No			underground	vertical shaft (Sec 7), connects to Spencer [illegible] shaft	1959.0000000000	1980.0000000000
0.0000000000	0.0000000000	241448.0000000000	3920067.0000000000	13.0000000000	topo	field location	federal	private	Bureau of Land Management	Cobb Resources	No			underground	[illegible] Dysart No. 2 as ventilation shaft	1961.0000000000	1982.0000000000
0.0000000000	0.0000000000	244636.0000000000	3914680.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	shaft, raise	1958.0000000000	1961.0000000000
0.0000000000	0.0000000000	242306.0000000000	3912940.0000000000	13.0000000000	topo	field location	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	shaft, Whitecap Dalco mined through shaft	1957.0000000000	1968.0000000000
0.0000000000	0.0000000000	246701.0000000000	[illegible]	13.0000000000	topo	map symbol	private	private	Atlantic Richfield Co	Atlantic Richfield Co	No			underground	3 declines (Sec 33), drill holes. Forest Group Road & Kerry mined as part of F-	1954.0000000000	1977.0000000000
0.0000000000	0.0000000000	245986.0000000000	3914083.0000000000	13.0000000000	topo	field location	private	private	Isabella O. Marquez Trust	Newmont Mining Corp	No			underground	2 30 degree declines, connects to Doc-Fine Mine	1958.0000000000	1981.0000000000
0.0000000000	0.0000000000	241154.0000000000	3913577.0000000000	13.0000000000	topo	field location	private	private	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp	Yes	1031		underground	shaft	1963.0000000000	1967.0000000000
0.0000000000	0.0000000000	260440.0000000000	3913181.0000000000	13.0000000000	topo	field location	private	private	Rio Grande Resources, Inc.	Rio Grande Resources, Inc.	No			underground	2 shafts, section 30 mined through shafts	1980.0000000000	1990.0000000000
0.0000000000	0.0000000000	245130.0000000000	3914213.0000000000	13.0000000000	topo	literature	federal (Sec 20), state (Sec 16), private (Sec	federal (Sec 20), state (Sec 16), private (Sec	Bureau of Land Management (Sec 20), State Land Office (Sec 16), private (Sec	Bureau of Land Management (Sec 20), State Land Office (Sec 16), private (Sec	No			underground	2 decline adits	1957.0000000000	1980.0000000000
0.0000000000	0.0000000000	241786.0000000000	3913470.0000000000	13.0000000000	topo	field location	federal (Sec 24), private (Sec 25)	federal (Sec 24), private (Sec 25)	Elkins Real Estate, Berryhill Ranch, Ltd. (Sec 25), Bureau of Land Management	Newmont Mining Corp. (Sec 25), Bureau of Land Managemetn (Sec 24)	Yes	1020		underground	22 degree decline (caved), numerous drill holes	0.0000000000	0.0000000000
0.0000000000	0.0000000000	[illegible]	3913420.0000000000	13.0000000000	topo	field location	private	private	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	Yes	363		underground, surface	decline (depth to ore 10-250 ft), 27 ft shaft, pits continuation of Haroush Mine	1962.0000000000	1981.0000000000
0.0000000000	0.0000000000	242490.0000000000	3912517.0000000000	13.0000000000	topo	literature	private	private			No			underground	pits	1957.0000000000	1971.0000000000
0.0000000000	0.0000000000	242878.0000000000	3912302.0000000000	13.0000000000	topo	literature	federal	federal	Bureau of Land Management	Bureau of Land Management	No			underground	shaft	1955.0000000000	1968.0000000000
0.0000000000	0.0000000000	257735.0000000000	3912632.0000000000	13.0000000000	topo	map symbol	federal	federal	U. S. Forest Service	U. S. Forest Service	No			underground	vertical shaft (Sec 30); heap leach testing	1969.0000000000	1971.0000000000
0.0000000000	0.0000000000	246162.0000000000	[illegible]	13.0000000000	topo	map symbol	patented	patented	United Nuclear Corp	Hecla Mining	No			underground	vertical shaft with drifts	1958.0000000000	1982.0000000000
0.0000000000	0.0000000000	250258.0000000000	3920184.0000000000	13.0000000000	topo	map symbol	state, private	state, private	State Land Office (Sec 36), Isabella O. Marquez Trust (Sec 1)	State Land Office (Sec 36), Hecla Mining & Newmont Mining Corp. (Sec 1)	No			underground	vertical shaft (Sec 36); Sec 1 mined through shaft	1960.0000000000	1988.0000000000
0.0000000000	0.0000000000	252658.0000000000	3916441.0000000000	13.0000000000	topo	literature	private	private	John E. Moiza, Fernandez Co	Newmont Mining Corp	No			underground	shaft (Sec 7)	1976.0000000000	1982.0000000000
0.0000000000	0.0000000000	247477.0000000000	3920770.0000000000	13.0000000000	topo	map symbol	private	private	United Nuclear Corp	Hecla Mining	No			underground	shaft	1959.0000000000	1980.0000000000
0.0000000000	0.0000000000	248609.0000000000	3920103.0000000000	13.0000000000	topo	map symbol	patented	patented	United Nuclear Corp	Hecla Mining	No			underground	vertical shaft, 2 ventilation shafts, 2nd shaft	1959.0000000000	1980.0000000000
0.0000000000	0.0000000000	238757.0000000000	3925042.0000000000	13.0000000000	topo	map symbol	private	private	Jerry & Luann Elkins	Newmont Mining Corp	Yes	357		underground	vertical shaft, decline shaft subsequently sunk	1958.0000000000	1981.0000000000
0.0000000000	0.0000000000	244435.0000000000	3925723.0000000000	13.0000000000	topo	map symbol	federal, private	federal, private	Rio Algom (Sec 17, 18), Bureau of Land Management (Sec 20)	Rio Algom (Sec 17, 18), Bureau of Land Management (Sec 20)	No			underground	vertical shaft (Sec 17); Sec 18 & 20 mined through shaft	1960.0000000000	2002.0000000000
0.0000000000	0.0000000000	243154.0000000000	[illegible]	13.0000000000	topo	map symbol	federal, private	federal, private	Rio Algom (Sec 19), Bureau of Land Management (Sec 20)	Rio Algom (Sec 19), Bureau of Land Management (Sec 20)	No			underground	vertical shaft (Sec 17) with haulage drifts; heap leach	1962.0000000000	2002.0000000000
0.0000000000	0.0000000000	236510.0000000000	3924627.0000000000	13.0000000000	topo	field location	private	private	Rio Algom	Rio Algom	Yes	356		underground	vertical shaft, heap leach	1954.0000000000	2002.0000000000
0.0000000000	0.0000000000	[illegible]	[illegible]	13.0000000000	topo	map symbol	private	private	Rio Algom	Newmont Mining Corp	Yes	355		underground	vertical shaft, solution mined	1960.0000000000	1989.0000000000
0.0000000000	0.0000000000	241031.0000000000	3923407.0000000000	13.0000000000	topo	field location	federal, private	federal, private	Rio Algom (Sec 24), Bureau of Land Management (Sec 20)	Rio Algom (Sec 24), Bureau of Land Management (Sec 20)	Yes	354		underground	vertical shaft (Sec 24); Section 26 mined through shaft, heap leach	1959.0000000000	2002.0000000000
0.0000000000	0.0000000000	241183.0000000000	3927540.0000000000	13.0000000000	topo	map symbol	private	private	Homestake Mining Co., Elbert Hourdy Ranch	Newmont Mining Corp	Yes	353		underground	vertical shaft; solution mined	1958.0000000000	1990.0000000000
0.0000000000	0.0000000000	240276.0000000000	[illegible]	13.0000000000	topo	literature	Indian allotment	Indian allotment	Navajo Allotee	Navajo Allotee	Yes	1035, 1011, 1012		surface, underground	decline shaft, pit, air vent	1952.0000000000	1980.0000000000
0.0000000000	0.0000000000	247768.0000000000	[illegible]	13.0000000000	topo	map symbol	private	private	Schmitt Ranches	Hecla Mining	No			underground	shaft, 2nd shaft 1000 ft east	1967.0000000000	1981.0000000000
0.0000000000	0.0000000000	247082.0000000000	3922760.0000000000	13.0000000000	topo	field location	private	private	Rio Algom	Rio Algom	No			underground	vertical shaft, heap leach	1970.0000000000	2002.0000000000
0.0000000000	0.0000000000	243565.0000000000	3922528.0000000000	13.0000000000	topo	field location	private	private	Rio Algom	Rio Algom	No			underground	vertical shaft (Sec 30); Sec 29 mined through shaft, heap leach	1954.0000000000	2002.0000000000
0.0000000000	0.0000000000	244387.0000000000	3921361.0000000000	13.0000000000	topo	map symbol	state, private	state, private	State Land Office (Sec 32), private	State Land Office (Sec 32), private	No			underground	vertical shaft (Sec 32); Sec 29 & 31 mined through shaft	1959.0000000000	1982.0000000000
0.0000000000	0.0000000000	246275.0000000000	3921045.0000000000	13.0000000000	topo	literature	private	private	Rio Algom	Rio Algom	No			underground	vertical shaft (Sec 33); Sec 29 mined through shaft, heap leach	1960.0000000000	2002.0000000000
0.0000000000	0.0000000000	249479.0000000000	3920572.0000000000	13.0000000000	topo	map symbol	private	private	Rio Algom	Rio Algom	No			underground	vertical shaft (Sec 35); heap leach; Sec 26 mined through shaft	1971.0000000000	2002.0000000000

MINING_HIS	PRODUCTION	PRODUCT_1	PRODUCT_2	COMMENTS_O	[illegible]	DISTURBANC	USGS_QUADR	RADIATION	POTENTIAL
1954-1959 Colemar Corp	a	2625.00000000000	5374.00000000000		[illegible]		Dos Lomas	dump 700 cps; workings 500-700 cps	highwall, tailings dump
1952-1959 Uranium Development Corp.; 1953, 1955, 1957 Moses Mirabal; 1953, 1955-1957 W.A. Martin; 1954, 1956 Amuranium Corp.; 1954 M.L. Larson; 1954 E & E Mining; 1954 William & Russell; 1954, 56 McElvain Brothers, 1958 Sutton & Sutton; 1958 Chane Uraniu	a	41914.00000000000	164670.00000000000		[illegible]		Dos Lomas		overburden, open cuts, mine dumps
1951 W. Barlow; 1952 F.A. Sutton; 1952-1954 Sixtmore Mining Co. All States Uranium Corp.; 1950 Brookhu	a	2753.00000000000	1034.00000000000		[illegible]		[illegible]		open trenches, waste dump
1961 Lumnus and Muse, Trusino Corp.	a	110.00000000000	362.00000000000		[illegible]		[illegible]	background 60 cps, high 4,500 cps	highwall
1954-1955 Anaconda Co.	a	32.00000000000	100.00000000000		[illegible]		[illegible]		
1950 Brown & Watson	a	117.00000000000	140.00000000000		[illegible]	USACE/EPA NA[illegible]	[illegible]	[illegible]	
1954 Westvaco Farris Mines	a	208.00000000000	704.00000000000		[illegible]		[illegible]	background 60 cps, face cut 125 cps	
1952-1959 Dakota Mining Co.; 1959 Black Rock Mining Co., Inc.; 1962-1963 Farris Mines, Inc.	a	5000.00000000000	12646.00000000000	includes Dakota Mine and Jones Mine	[illegible]	USACE/EPA NAUM	[illegible] Mountain	background 90-130 cps; adits 3,900 cps; stope 3,500 cps	collapsed face
1952-1959 Dakota Mining Co.; 1959 Black Rock Mining Co., Inc.; 1962-1963 Farris Mines, Inc.	a-f	0.00000000000	0.00000000000	included with Pat mine	2.30	USACE/EPA NAUM	Goat Mountain	background 50 cps, high 500 cps	boarded portal
1952-1959 Dakota Mining Co.; 1962-1963 Farris Mines, Inc.	a-f	0.00000000000	0.00000000000	included with Pat Mine	7.64	USACE/EPA NAUM	Goat Mountain	background 70 cps, max 200 cps	
1970-1980 Oct Todilto Exploration & Development; 1980 Oct - 1981 Todilto Exploration & Development (idle)	a	0.00000000000	0.00000000000		15.00	BLM inventory	Dos Lomas		
1952-1956 R.M. Shaw	a	482.00000000000	1223.00000000000		1.83	USACE/EPA NAUM	Bluewater	background 50 cps, pits 3,800 cps, dumps 1,500 cps	mine dumps, open pits
1954 Westvaco Farris Mines	a	23.00000000000	54.00000000000		2.80	USACE/EPA NAUM	Goat Mountain	background 60 cps, adit 800 cps	dump
1961 Ruth Mining & Drilling Co., Inc. sunk shaft; 1959-1963 L. Sutton and E.P. Moe	a	2407.00000000000	9746.00000000000				Dos Lomas	background 20-30 cps, dump high 2,200 cps	wooden headframe, ore piles, waste piles, collapsed decline
1952-1963 Moses Mirabal; 1954-1956 Skul-Munson; 1956 T. Munson; 1958 Chane Mining Co.; 1960 L. Sutton; 1962-1964 Homer Bayless	a	1435.00000000000	3770.00000000000		7.51	USACE/EPA NAUM	Dos Lomas	pit 1,100 cps	waste dumps
1952 John Gorsett; 1952-1958 Uranium Development Co.-Holly Uranium Co.; 1953, 1956, 1957 Moses Mirabal; 1953, 1955-1957 W.A. Martin; 1954 M.W. Larson Construction Co., Missouri Uranium Co., E & E Mining, William & Russell; 1954, 1958 Amuranium Corp. McEl	b	56749.00000000000	244947.00000000000	no production 1953-56, 1957, 1964			Dos Lomas		multiple dumps, waste rock piles
1952-1957 James F. Kenney; 1954 Fiesta Minerals; 1957-1958 Zia Mining Co.; 1960 Chane Mining Co.	b	3573.00000000000	31277.00000000000		4.00	U-db	Dos Lomas	background 70 cps; open pit 150-200 cps	waste piles, dump
1952 J.M. Kenney; 1954 La Jara Mining Co.; 1956 Fiesta Minerals 1957-1958 Zia Mining Co.; 1960 Chane Mining Co.	b-f	0.00000000000	0.00000000000	included with La Jara	4.00	U-db	Dos Lomas	background 70 cps; adit (8) 1,700 cps; waste pile 600 cps	tailings dump, caving, sloughing western adit, waste rock piles
1952-1959 Uranium Development Corp.; 1953, 1956, 1957, 1964 Moses Mirabal; 1953, 1955-1957 W.A. Martin; 1954, 1956 Amuranium Corp.; 1954 M.L. Larson; 1954 E & E Mining; 1954 William & Russell; 1954, 56 McElvain Brothers, 1958 Sutton & Sutton; 1958 Chane	b	3213.00000000000	11507.00000000000	includes production from Rex Blust No. 1-10 & Gay Eagle			Dos Lomas	max 1,000 cps	pit with ponding, open pits
1950 first ore shipment from Ambrosia Lake area; 1950 Fred Glover; 1951-1959 Anaconda; 1960, 1961-1962 Farris Mines	b	04424.00000000000	180778.00000000000				Dos Lomas	adit 10,000 cps	numerous pits, waste piles, tailings dump, high walls, waste rock piles
1956-1957 Mid-Continent Uranium; 1958 Mid-Continent Uranium Co.	b	6091.00000000000	52031.00000000000	some of the ore credited may have actually come from Barbara J No. 3	7.00	BLM inventory	Dos Lomas		
1951 Isabel Mateo Mining & Holding Co.; 1956 Holly Mining Co.; 1957 Lee Exploration Co.; 1958-1959 E.P. Moe; 1960-1961 KSN Co., Inc.; 1962-1963, 1966-1967 Farris Mines; 1976-1978 Reserve Oil & Minerals used as Poison Canyon Ventilation shaft	b	30354.00000000000	190096.00000000000		15.00	BLM inventory	Dos Lomas		
1956 Holly Mining Co.; 1957 Lee Exploration Co.; 1958-1959 E.P. Moe; 1960-1961 KSN Co., Inc.; 1962-1963, 1966-1967 Farris Mines	b-f	0.00000000000	0.00000000000	inc. with Grecon Hill			Dos Lomas		
1951-1952 Blue Peak Mining; 1953 Shattuck Denn Mining Corp.; 1955 St. Michael's College Foundation, Inc. - Sherman Operation; 1956-1957 Colohoma Uranium, Inc.; 1957-1958 Three Jacks Mining Co.; 1959-1960 Farris Mining Co.; 1960-1961 Lloyd O. Sutton; 1963	b	12061.00000000000	44020.00000000000		6.34	USACE/EPA NAUM	Dos Lomas		
1956-1958 E.P. Moe; 1960-1960 Blackrock Mining Co.; 1961 See Tee Mining; 1968 Bailey & Fife	b	7517.00000000000	27630.00000000000		6.00	BLM inventory	Dos Lomas		
1959-1961 Rio de Oro; 1959 Mid-Continent Uranium Corp.; 1961-1962 Homestake-Sapin; by 1980 United Nuclear-Homestake partners owned mine - no active mining; 1980-1983 Cobb Resources Corp. used as Sec. 12 ventilation shaft	b	237002.00000000000	804642.00000000000				Ambrosia Lake	background 75 cps; main dump intersecting road 1,500 cps; small dump 1,100 cps	1980 extensive mine dump, headframe, shaft & ventilation shaft, used as Cobb Section 12 ventilation; 1982: shaft escape hatch for UNC-Homestake area, now fence since 1980, subsidence hole behind fence
1955 Boyles Brothers Drilling Co. sunk shaft; 1957-1959 Westvaco Mineral Development (1958 Farris Mines subcontractor); 1959 Food Machinery & Chemical Corp.; 1960 Phillips Petroleum; 1959-1964 KSN Co.; 1963 United Nuclear; 1970s-1980s Ranchers Exploratio	b	66327.00000000000	254615.00000000000		1.00	MARP Prior Rec file	Dos Lomas		
1955-1957 Holly Uranium Corp.; 1957-1959 Hanosh Mining Co./Flat Top Mining Co.; 1963 Farris Mines; 1963-1968 Bailey & Fife (idle 1967-1968)	b	40663.00000000000	210486.00000000000		10.00	BLM Inventory	Dos Lomas		
1959-1961 Four Corners Exploration Co.; 1962 Homestake-Sapin	b	120551.00000000000	678510.00000000000				Dos Lomas	background 50cps; shaft 450cps; dump 200-400 cps	caving around reinforced concrete slab over shaft and footings; shaft WAS NOT backfilled, foundations, dumps
1970 Kop-Ran Development Corp. sunk shaft; 1977-1981 Ranchers Development & Exploration; 1984 Ranchers merged with Hecla	b	0.00000000000	0.00000000000	unknown	10.00	MARP PR Files	Dos Lomas		
1959-1961 Boyles Brothers Drilling Co.; 1961 Entrada-Boyles Joint Venture; 1961-1963 Entrada Corp.; 1964 Stella Dysart, 1964-1966 Homestake-Sapin Partners; 1980 United Nuclear-Homestake Partners controlled mine, no active mining occurred	b	357762.00000000000	794003.00000000000		33.88	USACE/EPA NAUM	Ambrosia Lake	shaft 400-600 cps high 1,200 cps; dump 600-1,500 cps	1989 PH file: shaft closed itself, unreliable; subsidence hole larger; fence broken; 1989 Anderson: shaft caved leaving 75-ft diameter x 75-ft deep depression, broken 6-ft high mesh fence; dump; small powder magazine
1954-1957 Lee Exploration; 1957-1958 Holly Minerals	b	108201.00000000000	512605.00000000000		10.00	BLM inventory	Dos Lomas		Per BLM 05.14.2002: no record that mine was submitted to NMAML, no reclamation work, shaft-ventilation-escapeway still open, erosional features
1956 Farris Mines drove incline; 1957-1959 Vallejo Uranium Mines, Inc.; 1959-1960 Sawson Oil & Mineral Co.; 1962-1963 Pentis Mining Co.	b	0458.00000000000	21735.00000000000		2.00	U-db	Dos Lomas	portal 350-600 cps	head frame & load out, caved incline, [illegible] in poor condition, powder magazine, mine dump
1958 Centennial Development Corp. sunk shaft; 1958-1960 United Western; 1959-1960 Jordan & Marshall; 1961 Hyde & Casper; 1964-1966 W.D. Tripp Mining; 1966-1967 James J. Goode (idle), 1970-1975 Kerr-McGee Corp. (idle); 1978-1980 Koppen Mining Construction	b	47808.00000000000	105319.00000000000				Dos Lomas	background 70cps; dump area 300-600 cps	1980: headframe and buildings, waste dump (tailings and low grade ore), recent closing so shaft not sealed; 1997: mine shaft collapsed, headframe collapsed into mine workings
1952 F.A. Sutton; 1952 Thompson & Williams; 1952-1953 Glen Williams; 1955-1958 Santa Fe Uranium Corp.; 1955-1959 Federal Uranium Corp., 1963-1964 Moss Mining Corp.; 1966 Cibola Mining Co.	b	25700.00000000000	98175.00000000000		12.08	USACE EPA NAUM	Bluewater	stockpile 1,000 cps, stope 150 cps	caved shaft, loadout facility, dump, stockpile
1957-1965 Haystack Mountain Development; 1965-1966 Haru Oole Santa Fe Pacific	b	21820.00000000000	138641.00000000000		17.01	USACE/EPA NAUM	Dos Lomas	face cuts 1,500 cps; mineralized zones 5,000 cps	16-ft soil overburden piles, pits, trenches
1959 Rialto Mining Co.; 1960 Febco Mines; 1960-1963 Febco Mines, Inc. (Bailey & Fife); 1963-1964 Farris Mines; 1980 Conoco had control mineral interests	b	10060.00000000000	37023.00000000000				San Mateo	background 50 cps, dump 800 cps with 1,500 cps/1500 cps, stock pile 600-1,000 cps	1993 shaft caved and 45-foot headframe toppled; crater 30-ft diameter and 20-ft deep, powder magazine, dump area near San Mateo Creek, stock pile area
1953-1954, 1958, 1960-1961 Haystack Mountain Development Co.; 1962 Santa Fe Pacific Railroad Co.; 1970, 1975 UNC	b	15736.00000000000	77121.00000000000				Dos Lomas	background 20-30 cps, dump 150 cps	
1957-1958 VCA, 1959-1960 United Western Jordan & Marshall	b	5240.00000000000	53340.00000000000				Ambrosia Lake	dump 700-900 cps	mine dump; powder magazine; shaft shows cratering - evidence of recent collapse, small timber headframe
1952 Chas Dews; 1952-1953 Silver Spur Mining Co.; 1955 Holly Uranium Co.; 1956 Holly Minerals; 1957-1960 Febco Mines, 1958 Holly Corp.; 1966 Farris Mines	b	5938.00000000000	29454.00000000000		4.16	USACE EPA NAUM	Goat Mountain	portals 350 cps; tailings dumps 600-1,200 cps	caved blasted adits, tailings piles
1962-1969 Febco Mines, 1968 Farris Mining	b-f	0.00000000000	0.00000000000	included with Febco	3.31	USACE EPA NAUM	Goat Mountain	pits 1,600-2,000 cps, dump 900 cps	dumps
1976 American Mine Services, Inc. sunk shaft, 1980 Teton Drilling Co. sunk ventilation shaft; 1977-1981 United Nuclear-Homestake Partners, 1981 Homestake Mining Co.	c	0.00000000000	0.00000000000		20.00	MARP PR Files	Ambrosia Lake		
1957 Farris Mines drove incline; 1958-1964 Calumet & Hecla; 1965-1966 United Nuclear Corp.; 1970-1972 Kerr-McGee Corp. (idle - planned leaching operations, never mined)	c	0.00000000000	3757847.00000000000				Dos Lomas	dump 400-7,500 cps, stockpile 10,000 cps; high readings on streambed road	buildings removed, portal secured with mesh gate; large dump, mine debris near creek, waste stockpiled ore near south creek bank
Four Corners Exploration Co.	c-f	0.00000000000	0.00000000000	included in Section 25 SEQ, may have never produced	0.58	USACE EPA NAUM	Dos Lomas	background 20-30 cps, outcrop 300-350cps	
First Westwater Canyon Member uranium discovery; 1955 Peabody & Fraka sunk shaft; 1959-1960 Rio de Oro; 1959-1960 Mid-Continent Exploration Co.; 1961-1962 Homestake-Sapin Partners; by 1980 United Nuclear-Homestake Partners owned mine - no active mining;	c	821922.00000000000	3705406.00000000000		58.55	USACE EPA NAUM	Ambrosia Lake	background 70 cps; shaft 700-1,000 cps, dump stockpile 400-700 cps	1980 headframe, dumps, buildings; 1982 shaft blocked by 2 plugs supported by timbers, buildings deteriorating
1957-1975 Four Corners Exploration Co.	c	244177.00000000000	900236.00000000000	production includes BG and Fire mines	30.00	BLM inventory	Dos Lomas	dumps 350-750 cps; waste washing into arroyo	waste piles; 2 waste dumps, erosion cutting into waste near arroyo, ore car head
1951 ATSF RR; 1956-1961 Haystack Mountain Development Corp.; 1962-1966 Santa Fe Pacific; 1970-1972 United Nuclear-Bailey & Fife; 1980-1981 Anacon Reserve Oil & Minerals	c	235156.00000000000	954064.00000000000		63.58	USACE EPA NAUM	Dos Lomas	background 20-30 cps, waste 900 cps; pits 2,000-3,300 cps	spoil piles unconsolidated overburden, waste piles, used as dump site
the first sandstone uranium discovery in the Grants district by Paddy Martinez; 1952-1955 E.P. Moe; 1952-1959 Haystack Mountain Development Co.; 1950-1962 Farris Mines, Inc.; 1970-1978 Todilto Exploration & Development & Reserve Oil and Minerals (Koppen	c	217086.00000000000	1004574.00000000000		30.00	MARP PR Files	Dos Lomas		
1956 Holly Minerals Corp. sunk shaft; 1957-58 Holly Minerals Corp.; 1958-1965 See Tee Mining Corp.; 1958-66, 1972 Hydro-Nuclear; 1978-1980, 1982 Cobb	c	181836.00000000000	770903.00000000000		27.40	USACE EPA NAUM	Ambrosia Lake		
1957 Patton & Gassein sunk shaft; 1957-1960 Kermac Nuclear Fuels Corp.; 1959-1962 S & A Mining Co.; 1964 Homestake-Sapin Partners; 1979 July Cobb starts to enter shaft; 1980-81 Cobb (stockpile prod only)	c	130767.00000000000	510035.00000000000		10.48	USACE/EPA NAUM	Goat Mountain	shaft 400 cps with high 800cps; dump 400-700 cps; ventilation shaft as ~4,000 cps	mine dump, metal shed, headframe, ventilation shaft
1958 Centennial Development sunk shaft; 1959-63 Mid-Continent Uranium Corp.-Williams Mining Partnership; 1963 F.M. Wright Mining Co.; 1964 Bailey & Fife; 1979-80 Todilto Exploration & Development Co.	c	102128.00000000000	485719.00000000000		5.00	BLM inventory	Dos Lomas		
1952-1956 F.O. Manol; 1956-1966 Rimrock Mining Co.; 1970-1971 Bailey & Fife; 1979-1981 Todilto Exploration & Development held lease and used as Piedra Trieste vent	c	91513.00000000000	484816.00000000000	includes production from T-20, Roundy and X-C	6.30	USACE EPA NAUM	Dos Lomas	background 20-30 cps; dumps 500-600 cps with 1,000-2,200 cps high	caved shaft, no fencing, waste dumps
1959 Boyles Brothers Drilling Co. sunk shaft; 1959-1961 Phillips Petroleum Co.; 1961-1964 KSN Mining Co.; 1978-1980 Koppen Mining Construction Co. (no mining, used as ventilation for Spencer); 1980 United Nuclear, Ranchers Exploration	c	76748.00000000000	237000.00000000000		2.00	MARP PR Files	Dos Lomas	background 80 cops; shaft area outside fence 350 cps; waste dumps 1,000-1,7000 cps with 2,000 spikes, high readin	caved shaft, tailings dump, waste dumps, ore stockpiles
1961 Anderson Development Co.; 1962-1963 Stella Dysart; 1977 Hydro Nuclear Corp.; 1977-1978 Cobb; 1979-1980 Koppen Mining & Construction Corp. (subcontractor to Cobb Resources); 1980 United Nuclear Corp.; 1980-1983 Cobb Resources (1983 idle)	c	74975.00000000000	211873.00000000000				Ambrosia Lake		
1956 Holly Minerals; 1958-1961 See Tee Mining Group; 1959-1960 Four Corners Exploration	c	72403.00000000000	338019.00000000000		8.00	BLM inventory	Dos Lomas		
1957 Mountain States Construction sunk shaft; 1957-1960 Dalco Uranium Co. (Mid-Continent Uranium subsidiary); 1962-1964 S & A Mining Co.; 1965-1967 Farris Mines, Inc.; 1967-1968 Mid-Continent Uranium Co.	c	58448.00000000000	232830.00000000000		8.00	BLM inventory	Dos Lomas		
1951-1959 Anaconda; 1961-1962, 1966 Farris Mines; 1971-1977 Homestake Mining Co.	c	48678.00000000000	304871.00000000000	produced unknown amount after 1970	30.00	MARP PR Files	Grants		
1958-1959 Westvaco Minerals; 1959-1961 Phillips Petroleum Co./KSN Co.; 1960 Bailey & Fife; 1977-1979 Ranchers Development & Exploration; 1977-1981 M & M Mining Co. (included Fines); 1984 Ranchers merged with Hecla	c	31950.00000000000	118052.00000000000		10.00	MARP PR Files	Dos Lomas		
1963-1967 Farris Mines	c-f	0.00000000000	0.00000000000	included in Section 25 SEQ	14.58	USACE/EPA NAUM	Dos Lomas	background 20-30 cps; dumps 3200 cps	open production shaft with stop, vent holes, mine dump extends Sec 24
discovery Chevron; 1975-1979 Harrison Western Corp. sunk shaft; 1980-1983 Gulf Mineral Resources Co.; 1985-1990 (June) Chevron Resources Co. (1970-1990 mine water recovery ion exchange plant)	c	0.00000000000	8000000.00000000000	estimated production	66.00	MARP	San Mateo		
1962-1969 Four Corners Exploration Co.; 1973 UNC-Homestake (Sec 16,17 underground), 1977-1981 M & M Mining (Sec 20 through Flea-Dora connection)	c-f	0.00000000000	0.00000000000	included with Dog Mine	20.00	BLM inventory	Dos Lomas		
	c-f	0.00000000000	0.00000000000	included in Section 25 SEQ, may have never produced	2.80	USACE EPA NAUM	Dos Lomas	background 20-30 cps; max 400cps	
1952-1964 Haystack Mountain Development Company; 1981 Anwan Co. Ltd/Reserve Oil & Minerals	c-f	0.00000000000	0.00000000000	included in Section 25 SEQ	21.09	USACE EPA NAUM	Dos Lomas	background 20-30 cps; waste 900 cps; pits 2,000-3,300 cps	open pits, trenches, spoil piles, mine dumps
1952-1956 F.O. Manol; 1956-1966 Rimrock Mining Co.; 1970-1971 Bailey & Fife; 1971 Rimrock Mining	c-f	0.00000000000	0.00000000000	included in Roundy-Manol lease			Dos Lomas	pits 300-600 cps	highwalls, ore stockpiles
1955-1962 Rimrock Mining Company; 1964 Midcontinent Uranium Co.; 1965-1968 Bailey & Fife	c-f	0.00000000000	0.00000000000	included with Roundy	5.00	BLM inventory	Dos Lomas		
1957 shaft sunk Centennial Development Co.; 1957-1962 Rare Metals Corp. & El Paso Natural Gas; 1962-1964 El Paso Natural Gas Co.; 1964-71 United Nuclear Corp & Teton Exploration Corp; 1981 Homestake Mining Co. exploration	d	837110.00000000000	2847700.00000000000				San Mateo	surface & groundwater contamination; waste dumps 8-25uR/hr; settling basins 100-450 uR/hr	1980: concrete slab over shaft, caving around slab exposed part of shaft, toppled ore bin, foundation slabs remain, debris, ventilation shaft with plate metal cover and motor foundation, 30-ft high dump with erosional features, some stockpiled ore in dum
1956 Phillips Petroleum discovered; 1957-1958 Boyles Brothers Drilling Co. sunk shaft; 1958-1962 Phillips Petroleum; 1962-1967 KSN Co. Inc.; 1967-1972 United Nuclear Corp.; 1982 Spuler Rock Mining	d	1110720.00000000000	6032047.00000000000		0.10	MARP PR Files	Ambrosia Lake		
1958-1960 Boyles Brothers Drilling Co. sunk shaft; 1960-1963 Phillips Petroleum Co.; 1963-1968 United Nuclear Corp.; 1967, 1968-1970 National Lead Co.; 1968 Molo Oil & Rare Metals Corp.; 1969-1971 Magna Oil Corp.; 1969-1984 Kerr-McGee; 1984-1988 Quivira M	d	893140.00000000000	7745017.00000000000	produced unknown amount after 1970			San Lucas Dam		
1958 discovered; 1972-1973 Harrison Western Corp. sunk shaft; 1976-1978 Kop-Ran Development Corp.; 1970-1982 Ranchers Exploration & Development; 1984 Ranchers merged with Hecla	d	0.00000000000	1500000.00000000000	estimated production			San Mateo		
1950-1963 Phillips Petroleum, 1963-1980 United Nuclear	d-f	0.00000000000	0.00000000000	included with Sandstone			Ambrosia Lake		
1958-1959 Boyles Brothers Drilling Co. sunk shaft; 1959-1963 Phillips Petroleum; 1963-1980 United Nuclear Corp.	d	1034255.00000000000	3540829.00000000000		8.00	MARP PR Files	Ambrosia Lake		
1957-1958 Utah Construction Co. & Centennial Development Co. sink shaft; 1958-1968 Homestake-Sapin Partners; 1961-1965 Rio de Oro; 1968-1981 United Nuclear-Homestake Partners, 1977 Ran-Con Corp. drives decline entry; 1981 Homestake Mining Co.	d	1213814.00000000000	3025024.00000000000		30.00	MARP PR Files	Goat Mountain		
1958-1960 Centennial Development Corp. sinks shaft; 1960-1964 Kermac Nuclear; 1962 Centennial Development Corp. sinks shaft; 1964-1980 Kerr-McGee; 1980-1984 Kerr-McGee mine water recovery; 1984-2002 Quivira Mining Co. (1983-2002 mine water recovery only)	d	1532495.00000000000	6125000.00000000000	produced unknown amount after 1970	22.00	MARP PR Files	Ambrosia Lake		
1970-1972 Boyles Brothers Drilling sunk shaft, 1973 South Prairie Construction Co. development work; 1973-1984 Kerr-McGee; 1984-2002 Quivira Mining Co. (mine water recovery)	d	0.00000000000	0.00000000000		10.00	MARP PR Files	Ambrosia Lake		
1957 Patton & Calsearo and Centennial Development Co. sunk shaft; 1958-1964 Kermac Nuclear; 1967 Centennial Development Company development work; 1964-1984 Kerr-McGee; 1984-2002 Quivira Mining Co. (1979-2002 mine water recovery)	d	2180051.00000000000	1045777.00000000000		37.00	MARP PR Files	Goat Mountain		
1956-1957 Frazier-Davis Construction Co. & Utah Construction Co. sink shaft; 1959-1968 Homestake-Sapin Partners, 1969-1982 United Nuclear-Homestake Partners; 1978-1980 Teton Exploration Drilling Co. sunk vent shafts; 1981-1989 Homestake Mining Co. (1983	d	2528797.00000000000	9079775.00000000000		100.00	MARP PR Files	Ambrosia Lake		
1957-1959 Stearns-Roger Manufacturing Co., Centennial Development Co. and Shaft Construction, Inc. sunk shaft; 1959-1964 Kerr-McGee Nuclear; 1965-1980 Kerr McGee; 1980-1984 Kerr-McGee mine water recovery; 1984-2002 Quivira Mining Co. mine water recovery	d	2200692.00000000000	8270830.00000000000		20.00	MARP PR Files	Ambrosia Lake		
1957 Utah Construction Company sunk shaft; 1958-1969 Homestake-Sapin Partners; 1969-1981 United Nuclear-Homestake Partners; 1981-1990 Homestake Mining Co. (1983-1990 mine water recovery only)	d	1701048.00000000000	6444880.00000000000		115.00	MARP PR Files	Ambrosia Lake		
1952-1957 Hanosh Mines, Inc.; 1980 Anwan Co. Ltd/Reserve Oil & Minerals	d	11110.00000000000	63752.00000000000		15.24	USACE/EPA NAUM	Dos Lomas	open pit 1,600 cps	load out facility, ore piles, inclined shaft, pile
1967-1970 United Nuclear; 1981 Spuler-Rock Mining	d	838789.00000000000	3714550.00000000000	some prod mined through Ann Lee	15.00	MARP	Ambrosia Lake		
1967-1969 Centennial Development Co. sunk shaft; 1978-1980 Teton Exploration Drilling Co. sunk ventilation shafts, 1970-1984 Kerr-McGee; 1984-2003 Quivira Mining Co. (mine water recovery)	d	68865.00000000000	282714.00000000000		20.00	MARP PR Files	Ambrosia Lake		
1957 Centennial Development Co. sunk shaft; 1958 United Western; 1959-1964 Kermac Nuclear; 1965-1984 Kerr-McGee; 1984-2002 Quivira Mining Co. (mine water recovery)	d	3594010.00000000000	8565704.00000000000		44.00	MARP PR Files	Ambrosia Lake		
1957 Centennial Development Corp. sunk shaft; 1958-1961 Homestake-New Mexico Partners; 1961-1968 Homestake-Sapin Partners, 1968-1981 United Nuclear-Homestake Partners; 1981-1982 Homestake Mining Co. (mine water recovery 1979-1982)	d	488031.00000000000	1927388.00000000000		60.00	MARP PR Files	Ambrosia Lake		
1957-1958 Centennial Development Corp. sunk shaft; 1959-1964 Ambrosia Lake Uranium Co., Kermac Nuclear and Phillips Petroleum Co.; 1965-1984 Kerr-McGee; 1984-2002 Quivira Mining Co. (1979-2002 mine water recovery)	d	1001925.00000000000	5176007.00000000000		28.00	MARP PR Files	Ambrosia Lake		
1969-1971 Boyles Brothers Drilling Co. sunk shaft; 1971-1984 Kerr-McGee; 1984-2002 Quivira Mining Co. (1979-2002 mine water recovery ion exchange plant)	d	0.00000000000	0.00000000000		40.00	MARP	Ambrosia Lake		

RECLAMATIO	REC PRIMAR	REGULATORY	CURRENT	[illegible]	MARP	[illegible]	[illegible]	OTHER AGEN	COMMENTS	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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1990 Oct Nov Contractor: Romero Excavation & Trucking; adit timbering removed, incline pit backfilled with mine waste, 2 air shafts backfilled with gravel	NM AMLP - Grants Uranium [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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1993 Mar Apr Contractor: Kham Co.; headframe demolished, shaft plugged with 3 ft bentonite plug and backfilled with waste from Barbara J No. 3 site; 1980: Anderson observed shaft backfilled & site regraded	NM AMLP - Grants Uranium [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1993 Mar Apr Contractor: Kham Co.; loading structure & powder magazine demolished, decline adits plugged with mine waste, 2 ventilation shafts backfilled, diversion ditches constructed on uphill slopes	NM AMLP - Grants Uranium [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1993 Mar Apr Contractor: Kham Co.; shaft backfilled	NM AMLP - Grants Uranium [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1990 Oct Nov Contractor: Romero Excavation & Trucking; timber headframe demolished, backfilled 5 adits with on-site mine waste	NM AMLP - Grants Uranium [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1990 Oct Nov Contractor: Romero Excavation & Trucking; powder box demolished, decline and adit backfilled with mine waste from Davenport and Mesa Top Mines	NM AMLP - Grants Uranium [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1989 shafts backfilled, surfaces recontoured, reseeded	Newmont Mining Corp	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1990 Oct Nov Contractor: Romero Excavation & Trucking; timber cribs removed from adit, chute removed, 5 subsidence areas backfilled with mine waste & gravel, adit backfilled with mine waste, 3 vent holes backfilled with gravel	NM AMLP - Grants Uranium [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
shaft cross-trenched and 10-15 ft concrete plug poured	Unknown	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1991 ? Cerrillos Land Co. regraded waste rock, shaft backfilled, revegetated	Ranchers Development & Exploration	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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1997 Nov AML installed 350 ft fence			BLM	Exempt - Prod Dates	NA	NM-149-4-2			combined with NMMK0068 Section 8, corrected so R13N	98.00000000000	34.00000000000
			Navajo Nation	Exempt - Navajo Allotee	NA	NM-149-3-2			combined NMMK0100 Section 14 SFO	90.00000000000	35.00000000000
			Navajo Nation	Exempt - Navajo Allotee - Fno		NM-149-4-21				100.00000000000	36.00000000000
			MMD - AML	Exempt - Prod Dates	NA	NM-150-3-1				101.00000000000	37.00000000000
1997 pits backfilled; 1984 (all Santa Fe Pacific Gold reclaimed & reseeded, debris removed; 1995 trespass dumping & minor erosion observed	Newmont Mining Corp		??? MMD - MARP and or AML	?? Not Exempt	MK020PR	NM-149-4-23			combined NMMK0238 Section 31 NWQ, NMMK0273 unknown Santa Fe Railroad - Ernst Dale	103.00000000000	38.00000000000
1990 Anderson: shaft backfilled, buildings removed, equipment salvaged; Per AML 1990 in Grants Phase 1 report: no threat, reclaimed	United Western		BLO, MMD - AML	Exempt - Prod Dates	NA	NM-149-1-4				104.00000000000	39.00000000000
			MMD - AML	Exempt - Prod Dates	NA	NM-149-2-4		CERCLIS # NMD986674801	combined MNMMK0254 Enbob	106.00000000000	40.00000000000
			MMD - AML	Exempt - Prod Dates	NA	NM-149-2-6				108.00000000000	41.00000000000
1991 Aug buildings removed and buried on site, borehole backfilled and sealed with reinforced concrete cap, shaft backfilled and capped with reinforced concrete cap; 1992 May-June earthwork to recontour cover waste piles, placement of topsoil; 1992 Ju	Homestake Mining Co.	MMD - MARP	MMD - MARP	Released 9 28 1995 - Young	MK004PR	No			combined NMMK0180 Section 13	41.00000000000	42.00000000000
1987 Santa Fe Pacific Gold declined adit shaft backfilled, structures removed, impacted; 12in topsoil depth - all sites	Newmont Mining Corp		MMD - AML	Exempt - Prod Dates	MK015PR	NM-149-4-8				40.00000000000	43.00000000000
			??? MMD- MARP	?? Not Exempt		No				47.00000000000	44.00000000000
			??? MMD - MARP and or MMD - AML	?? Not Exempt		NM-149-1-2				39.00000000000	45.00000000000
			BLM, ??? MMD - AML and or ??? MMD - MARP	?? Not Exempt	MK018PR (Sec 17)	NM-149-4-7	8 20 1986		combined NMMK0013 RJ Group	52.00000000000	46.00000000000
			??? MMD- MARP	?? Not Exempt		NM-149-4-17				48.00000000000	47.00000000000
1987 shafts backfilled, 1990 & 1994 additional reclamation activities, 2000 released (fine) reclaimed	Newmont Mining Corp	MMD - MARP	MMD - MARP	Released 9 8 2000 - Garcia Shuph	MK016PR	No		EPA NMD081[illegible]		45.00000000000	48.00000000000
			??? MMD - MARP	?? Not Exempt		No				54.00000000000	49.00000000000
by 1980 shaft secured with wire mesh fence			??? MMD- MARP	?? Not Exempt		NM-149-2-1				58.00000000000	50.00000000000
1980: shaft covered by Todilto; 1993 Mar Apr Contractor: Kham Co.: casing, water tank, timbering, etc. removed, 1 shafts closed with 2-ft bentonite plug and backfilled with riprap, 1 ventilation shaft backfilled with riprap, vent holes backfilled	NM AMLP - Grants Uranium Phase 2 MMD-02-6	BLM, MMD - AML	BLM, MMD - AML	Exempt - Prod Dates	NA	NM-149-4-10	8 10 1986			57.00000000000	51.00000000000
			MMD - AML	Exempt - Prod Dates	NA	NM-149-4-15			combined NMMK0144 Rozsly part of Todilto Exploration Poison-Trestle lease	58.00000000000	52.00000000000
	Newmont Mining Corp		??? MMD- MARP	No Release - insufficient wastes	MK014PR	NM-149-4-1				66.00000000000	53.00000000000
			??? MMD- MARP	?? Not Exempt		No				64.00000000000	54.00000000000
1993 Mar Apr Contractor: Kham Co.: casing, water tank, timbering, etc. removed, 1 shafts closed with 2-ft bentonite plug and backfilled with riprap, 1 ventilation shaft backfilled with riprap, vent holes backfilled	NM AMLP - Grants Uranium Phase 2 MMD-02-5	MMD - AML	MMD - AML	Exempt - Prod Dates	NA	NM-149-4-6	8 21 1986		combined East Malpais & NMMK0080 Malpais	60.00000000000	55.00000000000
1993 Mar Apr Contractor: Kham Co.: headframe removed, shaft backfilled with mine waste (shaft collapsed during construction)	NM AMLP - Grants Uranium Phase 2 MMD-02-5	BLM, MMD - AML	BLM, MMD - AML	Exempt - Prod Dates	NA	No	8 10 1986		combined with NMMK0342 Whitecap	67.00000000000	56.00000000000
1970s surface buildings removed; 6 17 1994 reclamation completed, reclamation included permanent closure of portals Nos. 1, 2, 4, 5 and vent raise (portal No. 3 never developed), mine waste backfilled into tunnels and portals, slopes 3h:1v or less, 12 in	ARCO - Homestake	MMD - MARP	MMD - MARP	Released 7 28 1996 - Dasquez	CI001PR	NM-175-1-1			combined with NMCI0012 Forest Group	63.00000000000	57.00000000000
1991 1992 Cerrillos Land Co. both declines sealed, erosion control features, debris removed, revegetated, waste rock regraded	Ranchers Development & Exploration	MMD - MARP	MMD - MARP	Released 9 29 1995 - Young	MK001PR	No			combined with NMMK0050 Doris West Extension	70.00000000000	58.00000000000
			MMD - AML	Exempt - Prod Dates		NM-149-4-18				50.00000000000	59.00000000000
	Rio Grande Resources, Inc.	MMD - MARP	MMD - MARP	Permitted	CI002RE	No		NMED DP-61, DP-117, NRC Docket No. 40-8084, 40-007	combined NMMK0110 Mt Taylor	38.00000000000	60.00000000000
1993 Mar Apr Contractor: Kham Co.: 2 adits reclaimed, removed wire mesh and tin closures, removed timbering, backfilled with mine waste, 30-mil PRC cover installed on opening, 12" topsoil, diversion ditches constructed on uphill slopes	NM AMLP - Grants Uranium Phase 2 MMD-02-5	BLM, MMD - AML	BLM, MMD - AML	?? Not Exempt	NA	No	8 17 1986		combined NMMK0185 Homestake UNC Section 16, NMMK0186 Homestake UNC Section 17, MARP counted locale as: 17 in find	53.00000000000	61.00000000000
			MMD - AML	Exempt - Prod Dates		No				48.00000000000	62.00000000000
1980s Amerada Hess backfilled features after lease expired; 1987 Santa Fe Pacific reclaimed & reseeded; 1994 additional reclamation, debris removed, rainwater impoundment for livestock, 12" soil depth	Newmont Mining Corp		??? MMD- MARP	?? Not Exempt	MK019PR	NM-149-4-19				40.00000000000	63.00000000000
		MMD - AML	MMD - AML	Exempt - Prod Dates	NA	NM-149-4-16				59.00000000000	64.00000000000
1990 Oct Nov Contractor: Romero Excavation & Trucking; shaft collar and grating removed, 2 subsidence areas backfilled with mine waste, 5 vent holes backfilled with gravel, shaft backfilled with waste material, 1 ft topsoil, seeded	NM AMLP - Grants Uranium Phase 1 MMD-90-4	BLM, MMD - AML	BLM, MMD - AML	Exempt - Prod Dates	NA	NM-149-4-13	8 15-16 86, 8-10		combined NMMK0044 X-C shaft	72.00000000000	65.00000000000
1980s Homestake backfilled main shaft with mine waste material		USFS	USFS	Exempt - Prod Dates	NA	NM-150-3-2		US EPA CERCLIS # NM1220075615		30.00000000000	66.00000000000
portion of mine included in Phillips UMTRA Title I site; 1994 shaft backfilled with mill mine waste & capped with 4ft thick, 20 sq ft concrete slab, barbed wire fence, 3-ft topsoil cover, seeded	United Nuclear Corp	MMD - MARP	MMD - MARP	No Release - Young	MK027PR	No				23.00000000000	67.00000000000
1990 Quivira reclaimed per BLO specs; 3-cased vent holes remain on site as monitoring wells	Rio Algom & Newmont Mining Corp	MMD - MARP	MMD - MARP, BLO	Released 9 28 1995	MK017PR, MK026PR	No			combined NMMK0151 Section 1 & NMMK0251 Section 36	17.00000000000	68.00000000000
1982 mined-out areas backfilled with tailings, shaft sealed with concrete plug, portal sealed with concrete plug; 1993 Fed Reg Docket No. 40-8014 released 5 13 1993	Hecla Mining	NRC	NRC	Exempt - NRC license	MK003PR	No		NRC Source Mat License SUA-1482	combined NMMK0183 Palo Verde Group	32.00000000000	69.00000000000
	United Nuclear Corp	MMD - MARP	MMD - MARP	No Release - Young	MK029PR	No				29.00000000000	70.00000000000
1980s headframe removed, 1994 fill, barbed-wire fence, shafts backfilled and capped with concrete cap, 2ft soil depth, seeded	United Nuclear Corp	MMD - MARP	MMD - MARP	No Release - Young	MK020PR	No				28.00000000000	71.00000000000
1991 Aug-Sept. buildings demolished & buried on site, shaft & decline backfilled & capped with reinforced concrete, boreholes backfilled & capped, ponds contaminant berms flattened; 1992 May-June earthwork to recontour cover waste piles, placement of	Homestake Mining Co	MMD - MARP	MMD - MARP	Released 9 28 1995 - Young	MK005PR	No				27.00000000000	72.00000000000
1994 June Quivira reclaimed	Rio Algom	MMD - MARP	MMD - MARP	Permitted	MK003RE	No		NMED DP-362	combined NMMK0189 Section 17, NMMK0197 Section 18, NMMK0201 Section 20	21.00000000000	73.00000000000
1994 June Quivira reclaimed	Rio Algom	MMD - MARP	MMD - MARP	Released 10 19 2000 - Bland	MK022PR	No			combined NMMK0202 Section 20	36.00000000000	74.00000000000
1994 June Quivira reclaimed	Rio Algom	MMD - MARP	MMD - MARP	Permitted	MK003RE	No		NMED DP-362		13.00000000000	75.00000000000
1991 August buildings, headframe, hoist equipment, IX plant & trash removed, building material buried on site, IX plant disposed at Grants mill site, shaft backfilled & sealed with reinforced concrete shaft, boreholes backfilled and capped with concrete	Homestake Mining Co	MMD - MARP	MMD - MARP	Released 10 1 1997 - Young	MK023PR	No				15.00000000000	76.00000000000
1994 June Quivira reclaimed	Rio Algom	MMD - MARP	MMD - MARP	Permitted	MK003RE	No		NMED DP-362	combined NMMK0224 Section 20	18.00000000000	77.00000000000
1991 August buildings, headframe, hoist equipment, IX plant & trash removed, building material buried on site, IX plant disposed at Grants mill site, shaft backfilled & sealed with reinforced concrete, boreholes backfilled & capped with concrete, recd	Homestake Mining Co	MMD - MARP	MMD - MARP	Released 9 28 1995 - Toney	MK006PR	No				18.00000000000	78.00000000000
			Navajo Nation	Exempt - Navajo Allotee	NA	NM-149-4-20			combined NMMK0338 Vanadium	37.00000000000	79.00000000000
	United Nuclear Corp	MMD - MARP	MMD - MARP	Permitted	MK005RE	No			combined NMMK0225 Section 27	20.00000000000	80.00000000000
1994 June Quivira reclaimed	Rio Algom	MMD - MARP	MMD - MARP	Released 10 30 1998 - Shepherd	MK025PR	No				35.00000000000	81.00000000000
1994 June Quivira reclaimed	Rio Algom	MMD - MARP	MMD - MARP	Released 10 30 1998 - Shepherd	MK024PR	No			combined NMMK0357 Section 29, NMMK0231 Section 29 & NMMK0241 Section 31	17.00000000000	82.00000000000
1991 Aug-Sept buildings removed & buried on site, boreholes backfilled & sealed with reinforced concrete, shaft backfilled & capped with reinforced concrete, contaminant berms pushed into ponds, earthwork to recontour cover waste piles, placement of to	Homestake Mining Co	MMD - MARP	MMD - MARP	Released 9 28 1995 - Young	MK007PR	NM-149-1-6				30.00000000000	83.00000000000
1994 June Quivira reclaimed	Rio Algom	MMD - MARP	MMD - MARP	Permitted	MK003RE	No		NMED DP-362	combined NMMK0233 Section 29	22.00000000000	84.00000000000
	Rio Algom	MMD - MARP	MMD - MARP	Permitted	MK002RE, MK003RE	No		NMED DP-67, DP-264	combined NMMK0223 Section 20	19.00000000000	85.00000000000

USGS_QUADR	HYDROLOGY	RECEIVING_	RECLAMATIO	REC_PRIM_C	UMTRA_CLAS	DOE_LEGACY	REGULATORY	MARP_PERMI	NMED_DP	US_EPA_CER	NRC_NO_	MSHA_NO	COMMENTS
Ambrosia		Arroyo de	2003 mill	Rio Aglom	UMTRCA Title I	No	US EPA, NRC	No	DP-169, NPDES NMR05B167	NMD005570015	License No. SUA-1473, Docket No. 40-890	2900776	
Bluewater			1989 mill	ARCO	UMTRCA Title I	US DOE	US DOE	No		NMD007106891	License No. SUA-1473, Docket No. 40-890	2900772	
Ambrosia			1987-1989	DOE	UMTRCA Title I	US DOE	US DOE	No	DP-34			2901070	originally 11 acres, wind & water spread contamination to
Grants			1990 mill decor	Homestake Mir	UMTRCA Title II	No	US EPA Superf	No	DP-200, DP-725	NMD007860935	License No. SUA-1471, Docket No. 40-8903	2900775	

License Number
SUA-1471

Docket or Reference Number
40-8903

Amendment No. 40

MATERIALS LICENSE
SUPPLEMENTARY SHEET

B. The following ground water protection standards are established for each designated aquifer/zone as described in Ground-Water Hydrology for Support of Background Concentration at the Grants Reclamation Site (Hydro-Engineering, December 2001) and Background Water Quality Evaluation of the Chinle Aquifers (Homestake Mining Company and Hydro-Engineering, October 2003):

Constituents	Alluvial Aquifer	Chinle Mixing Zone	Upper Chinle Non-Mixing Zone	Middle Chinle Non-Mixing Zone	Lower Chinle Non-Mixing Zone
Selenium (mg/L)	0.32	0.14	0.06	0.07	0.32
Uranium (mg/L)	0.16	0.18	0.09	0.07	0.03
Molybdenum (mg/L)	0.1	0.1	0.1	0.1	0.1
Sulfate (mg/L)	1500	1750	914	857	2000
Chloride (mg/L)	250	250	412	250	634
TDS (mg/L)	2734	3140	2010	1560	4140
Nitrate (mg/L)	12	15	*	*	*
Vanadium (mg/L)	0.02	0.01	0.01	*	*
Thorium-230 (pCi/L)	0.3	*	*	*	*
Ra-226 + Ra-228	5	*	*	*	*
* - ground-water protection standards not necessary for the constituents in the indicated zones					

The constituents listed above for the alluvial aquifer must not exceed the specified concentration limit at compliance monitoring wells (former point of compliance wells) D1, X, and S4. At present, no compliance monitoring wells have been designated for the Chinle Mixing Zone or the Upper, Middle or Lower Chinle Non-Mixing Zones for the purpose of implementing the ground water protection standards listed above for these zones. The licensee shall propose compliance monitoring wells for the Chinle Mixing Zone and the Upper, Middle and Lower Chinle Non-Mixing Zones in a revised Corrective Action Plan to be submitted to the NRC no later than December 31, 2006. NRC will evaluate the proposed compliance monitoring wells and, if acceptable, will incorporate them into the license as compliance locations for the ground water protection standards listed above. NRC will notify the licensee and request new proposed compliance monitoring well locations from the licensee, if any of the well locations are determined to be unacceptable.

C. Implement the corrective action program described in the September 15, 1989 submittal, as modified by the reverse osmosis system described in the January 15, 1998 submittal with the objective of returning the concentrations of molybdenum, selenium, thorium-230, uranium, and vanadium to the site standards as listed in LC 35B. In addition, the reverse osmosis system will include the addition of Sample Point 2 downstream of the Mixing Tank. Composite samples from Sample Point 2 will be taken monthly and analyzed for U and Mo.

NRC FORM 374

U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE

...uant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and the applicable parts ...itle 10, Code of Federal Regulations, Chapter I, Parts 19, 20, 30, 31, 32, 33, 34, 35, 36, 39, 40, 51, 70, and 71, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Homestake Mining Company	3. License Number SUA-1471 Amendment No. 40
2. P.O. Box 98 Grants, New Mexico 87020	4. Expiration Date Until terminated 5. Docket No. 40-8903 Reference No.

6. Byproduct Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum amount that Licensee May Possess at Any One Time Under This License
Uranium	Any	Unlimited

Authorized Place of Use: The licensee's uranium mill located in Cibola County, New Mexico.

[Applicable Amendments: 12, 29]

10. This license authorizes only the possession of residual uranium and byproduct material in the form of uranium waste tailings and other byproduct waste generated by the licensee's past milling operations in accordance with Tables 1 and 3 and the procedures submitted by letter dated September 2, 1993, as modified by letter dated March 7, 1996.

    Anywhere the word "will" is used, it shall denote a requirement.

    [Applicable Amendments: 2, 6, 12, 16, 24]

11. DELETED by Amendment No. 21.

12. Periodic embankment inspections of the large and small tailings embankment shall be conducted by knowledgeable individuals who are familiar with the site and the embankment design. An annual embankment status report shall be included in the Annual Report (see LC 42).

    [Applicable Amendments: 2, 12, 14, 24, 34]

13. DELETED by Amendment No. 27.

Release of equipment or packages from the restricted area shall be in accordance with the attachment to SUA-1471 entitled, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984.

[Applicable Amendments: 21, 31]

Enclosure

REFERENCES

9-12

CAS No.	Contaminant	MCL (mg/l)
(1) 15972–60–8	Alachlor	0.002
(2) 116–06–3	Aldicarb	0.003
(3) 1646–87–3	Aldicarb sulfoxide	0.004
(4) 1646–87–4	Aldicarb sulfone	0.002
(5) 1912–24–9	Atrazine	0.003
(6) 1563–66–2	Carbofuran	0.04
(7) 57–74–9	Chlordane	0.002
(8) 96–12–8	Dibromochloropropane	0.0002
(9) 94–75–7	2,4-D	0.07
(10) 106–93–4	Ethylene dibromide	0.00005
(11) 76–44–8	Heptachlor	0.0004
(12) 1024–57–3	Heptachlor epoxide	0.0002
(13) 58–89–9	Lindane	0.0002
(14) 72–43–5	Methoxychlor	0.04
(15) 1336–36–3	Polychlorinated biphenyls	0.0005
(16) 87–86–5	Pentachlorophenol	0.001
(17) 8001–35–2	Toxaphene	0.003
(18) 93–72–1	2,4,5-TP	0.05
(19) 50–32–8	Benzo[a]pyrene	0.0002
(20) 75–99–0	Dalapon	0.2
(21) 103–23–1	Di(2-ethylhexyl) adipate	0.4
(22) 117–81–7	Di(2-ethylhexyl) phthalate	0.006
(23) 88–85–7	Dinoseb	0.007
(24) 85–00–7	Diquat	0.02
(25) 145–73–3	Endothall	0.1
(26) 72–20–8	Endrin	0.002
(27) 1071–53–6	Glyphosate	0.7
(28) 118–74–1	Hexacholorbenzene	0.001
(29) 77–47–4	Hexachlorocyclopentadiene	0.05
(30) 23135–22–0	Oxamyl (Vydate)	0.2
(31) 1918–02–1	Picloram	0.5
(32) 122–34–9	Simazine	0.004
(33) 1746–01–6	2,3,7,8-TCDD (Dioxin)	3×10^{-8}

[56 FR 3593, Jan. 30, 1991, as amended at 56 FR 30280, July 1, 1991; 57 FR 31846, July 17, 1992; 59 FR 34324, July 1, 1994]

§ 141.62 Maximum contaminant levels for inorganic contaminants.

(a) [Reserved]

(b) The maximum contaminant levels for inorganic contaminants specified in paragraphs (b) (2)–(6), (b)(10), and (b) (11)–(16) of this section apply to community water systems and non-transient, non-community water systems. The maximum contaminant level specified in paragraph (b)(1) of this section only applies to community water systems. The maximum contaminant levels specified in (b)(7), (b)(8), and (b)(9) of this section apply to community water systems; non-transient, non-community water systems; and transient non-community water systems.

Contaminant	MCL (mg/l)
(1) Fluoride	4.0
(2) Asbestos	7 Million Fibers/liter (longer than 10 μm).
(3) Barium	2
(4) Cadmium	0.005
(5) Chromium	0.1
(6) Mercury	0.002
(7) Nitrate	10 (as Nitrogen)
(8) Nitrite	1 (as Nitrogen)
(9) Total Nitrate and Nitrite	10 (as Nitrogen)
(10) Selenium	0.05
(11) Antimony	0.006
(12) Beryllium	0.004
(13) Cyanide (as free Cyanide).	0.2
(14) [Reserved]	
(15) Thallium	0.002
(16) Arsenic	0.01

(c) The Administrator, pursuant to section 1412 of the Act, hereby identifies the following as the best technology, treatment technique, or other means available for achieving compliance with the maximum contaminant levels for inorganic contaminants identified in paragraph (b) of this section, except fluoride:

BAT FOR INORGANIC COMPOUNDS LISTED IN SECTION 141.62(B)

Chemical Name	BAT(s)
Antimony	2,7
Arsenic[4]	1, 2, 5, 6, 7, 9, 12[5]

with this subpart beginning January 1, 2004.

(2) Transient NCWSs. Subpart H systems serving 10,000 or more persons and using chlorine dioxide as a disinfectant or oxidant must comply with the chlorine dioxide MRDL beginning January 1, 2002. Subpart H systems serving fewer than 10,000 persons and using chlorine dioxide as a disinfectant or oxidant and systems using only ground water not under the direct influence of surface water and using chlorine dioxide as a disinfectant or oxidant must comply with the chlorine dioxide MRDL beginning January 1, 2004.

(c) The Administrator, pursuant to Section 1412 of the Act, hereby identifies the following as the best technology, treatment techniques, or other means available for achieving compliance with the maximum residual disinfectant levels identified in paragraph (a) of this section: control of treatment processes to reduce disinfectant demand and control of disinfection treatment processes to reduce disinfectant levels.

[63 FR 69465, Dec. 16, 1998, as amended at 66 FR 3776, Jan. 16, 2001]

§ 141.66 Maximum contaminant levels for radionuclides.

(a) [Reserved]

(b) *MCL for combined radium-226 and -228.* The maximum contaminant level for combined radium-226 and radium-228 is 5 pCi/L. The combined radium-226 and radium-228 value is determined by the addition of the results of the analysis for radium-226 and the analysis for radium-228.

(c) *MCL for gross alpha particle activity (excluding radon and uranium).* The maximum contaminant level for gross alpha particle activity (including radium-226 but excluding radon and uranium) is 15 pCi/L.

(d) *MCL for beta particle and photon radioactivity.* (1) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water must not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year (mrem/year).

(2) Except for the radionuclides listed in table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents must be calculated on the basis of 2 liter per day drinking water intake using the 168 hour data list in "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure," NBS (National Bureau of Standards) Handbook 69 as amended August 1963, U.S. Department of Commerce. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of this document are available from the National Technical Information Service, NTIS ADA 280 282, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. The toll-free number is 800–553–6847. Copies may be inspected at EPA's Drinking Water Docket, 401 M Street, SW., Washington, DC 20460; or at the Office of the Federal Register, 800 North Capitol Street, NW., Suite 700, Washington, DC. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem/year.

TABLE A.—AVERAGE ANNUAL CONCENTRATIONS ASSUMED TO PRODUCE: A TOTAL BODY OR ORGAN DOSE OF 4 MREM/YR

1. Radionuclide	Critical organ	pCi per liter
2. Tritium	Total body	20,000
3. Strontium-90	Bone Marrow	8

(e) *MCL for uranium.* The maximum contaminant level for uranium is 30 µg/L.

(f) *Compliance dates.* (1) Compliance dates for combined radium-226 and -228, gross alpha particle activity, gross beta particle and photon radioactivity, Drinking Water Act, as amended (42 U.S.C. 300g–1). These regulations control contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance of drinking water. At considerably higher concentrations of these contaminants, health implications may also exist as well as aesthetic degradation. The regulations are not Federally enforceable but are intended as guidelines for the States.

§ 143.2 Definitions.

(a) *Act* means the Safe Drinking Water Act as amended (42 U.S.C. 300f *et seq.).*

(b) *Contaminant* means any physical, chemical, biological, or radiological substance or matter in water.

(c) *Public water system* means a system for the provision to the public of piped water for human consumption, if such a system has at least fifteen service connections or regularly serves an average of at least twenty-five individuals daily at least 60 days out of the year. Such term includes (1) any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system, and (2) any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system. A public water system is either a "community water system" or a "non-community water system."

(d) *State* means the agency of the State or Tribal government which has jurisdiction over public water systems. During any period when a State does not have responsibility pursuant to section 1443 of the Act, the term "State" means the Regional Administrator, U.S. Environmental Protection Agency.

(e) *Supplier of water* means any person who owns or operates a public water system.

(f) *Secondary maximum contaminant levels* means SMCLs which apply to public water systems and which, in the judgement of the Administrator, are requisite to protect the public welfare. The SMCL means the maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of public water system. Contamimants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

[44 FR 42198, July 19, 1979, as amended at 53 FR 37412, Sept. 26, 1988]

§ 143.3 Secondary maximum contaminant levels.

The secondary maximum contaminant levels for public water systems are as follows:

Contaminant	Level
Aluminum	0.05 to 0.2 mg/l.
Chloride	250 mg/l.
Color	15 color units.
Copper	1.0 mg/l.
Corrosivity	Non-corrosive.
Fluoride	2.0 mg/l.
Foaming agents	0.5 mg/l.
Iron	0.3 mg/l.
Manganese	0.05 mg/l.
Odor	3 threshold odor number.
pH	6.5–8.5.
Silver	0.1 mg/l.
Sulfate	250 mg/l.
Total dissolved solids (TDS)	500 mg/l.
Zinc	5 mg/l.

These levels represent reasonable goals for drinking water quality. The States may establish higher or lower levels which may be appropriate dependent upon local conditions such as unavailability of alternate source waters or other compelling factors, provided that public health and welfare are not adversely affected.

[44 FR 42198, July 19, 1979, as amended at 51 FR 11412, Apr. 2, 1986; 56 FR 3597, Jan. 30, 1991]

§ 143.4 Monitoring.

(a) It is recommended that the parameters in these regulations should be monitored at intervals no less frequent than the monitoring performed for inorganic chemical contaminants listed in the National Interim Primary Drinking Water Regulations as applicable to community water systems. More frequent monitoring would be appropriate for specific parameters such as pH, color, odor or others under certain circumstances as directed by the State.

(b) Measurement of pH, copper and fluoride to determine compliance under

TITLE 20 ENVIRONMENTAL PROTECTION
CHAPTER 6 WATER QUALITY
PART 2 GROUND AND SURFACE WATER PROTECTION

20.6.2.1 **ISSUING AGENCY:** Water Quality Control Commission
[12-1-95; 20.6.2.1 NMAC - Rn, 20 NMAC 6.2.I.1000, 1-15-01]

20.6.2.2 **SCOPE:** All persons subject to the Water Quality Act, NMSA 1978, Sections 74-6-1 et seq.
[12-1-95; 20.6.2.2 NMAC - Rn, 20 NMAC 6.2.I.1001, 1-15-01]

20.6.2.3 **STATUTORY AUTHORITY:** Standards and Regulations are adopted by the commission under the authority of the Water Quality Act, NMSA 1978, Sections 74-6-1 through 74-6-17.
[2-18-77, 9-20-82, 12-1-95; 20.6.2.3 NMAC - Rn, 20 NMAC 6.2.I.1002, 1-15-01]

20.6.2.4 **DURATION:** Permanent.
[12-1-95; 20.6.2.4 NMAC - Rn, 20 NMAC 6.2.I.1003, 1-15-01]

20.6.2.5 **EFFECTIVE DATE:** December 1, 1995 unless a later date is cited at the end of a section.
[12-1-95, 11-15-96; 20.6.2.5 NMAC - Rn, 20 NMAC 6.2.I.1004, 1-15-01; A, 1-15-01]

20.6.2.6 **OBJECTIVE:** The objective of this Part is to implement the Water Quality Act, NMSA 1978, Sections 74-6-1 et seq.
[12-1-95; 20.6.2.6 NMAC - Rn, 20 NMAC 6.2.I.1005, 1-15-01]

20.6.2.7 **DEFINITIONS**: Terms defined in the Water Quality Act, but not defined in this part, will have the meaning given in the act. As used in this part:

A. **"abandoned well"** means a well whose use has been permanently discontinued or which is in a state of disrepair such that it cannot be rehabilitated for its intended purpose or other purposes including monitoring and observation;

B. **"abate" or "abatement"** means the investigation, containment, removal or other mitigation of **water pollution;**

C. **"abatement plan"** means a description of any operational, monitoring, contingency and closure requirements and conditions for the prevention, investigation and abatement of water pollution, and includes Stage 1, Stage 2, or Stage 1 and 2 of the abatement plan, as approved by the secretary;

D. **"adjacent properties"** means properties that are contiguous to the discharge site or property that would be contiguous to the discharge site but for being separated by a public or private right of way, including roads and highways.

E. **"background"** means, for purposes of ground-water abatement plans only and for no other purposes in this part or any other regulations including but not limited to surface-water standards, the amount of ground-water contaminants naturally occurring from undisturbed geologic sources or water contaminants which the responsible person establishes are occurring from a source other than the responsible person's facility; this definition shall not prevent the secretary from requiring abatement of commingled plumes of pollution, shall not prevent responsible persons from seeking contribution or other legal or equitable relief from other persons, and shall not preclude the secretary from exercising enforcement authority under any applicable statute, regulation or common law;

F. **"casing"** means pipe or tubing of appropriate material, diameter and weight used to support the sides of a well hole and thus prevent the walls from caving, to prevent loss of drilling mud into porous ground, or to prevent fluid from entering or leaving the well other than to or from the injection zone;

G. **"cementing"** means the operation whereby a cementing slurry is pumped into a drilled hole and/or forced behind the casing;

H. **"cesspool"** means a **"drywell"** that receives untreated domestic liquid waste containing human excreta, and which sometimes has an open bottom and/or perforated sides. A large capacity cesspool means a cesspool that receives greater than 2,000 gallons per day of untreated domestic liquid waste;

I. **"collapse"** means the structural failure of overlying materials caused by removal of underlying materials;

C. The standards are not intended as maximum ranges and concentrations for use, and nothing herein contained shall be construed as limiting the use of waters containing higher ranges and concentrations.
[2-18-77; 20.6.2.3101 NMAC - Rn, 20 NMAC 6.2.III.3101, 1-15-01]

20.6.2.3102: [RESERVED]
[12-1-95; 20.6.2.3102 NMAC - Rn, 20 NMAC 6.2.III.3102, 1-15-01]

20.6.2.3103 STANDARDS FOR GROUND WATER OF 10,000 mg/l TDS CONCENTRATION OR LESS: The following standards are the allowable pH range and the maximum allowable concentration in ground water for the contaminants specified unless the existing condition exceeds the standard or unless otherwise provided in Subsection D of Section 20.6.2.3109 NMAC. Regardless of whether there is one contaminant or more than one contaminant present in ground water, when an existing pH or concentration of any water contaminant exceeds the standard specified in Subsection A, B, or C of this section, the existing pH or concentration shall be the allowable limit, provided that the discharge at such concentrations will not result in concentrations at any place of withdrawal for present or reasonably foreseeable future use in excess of the standards of this section. These standards shall apply to the dissolved portion of the contaminants specified with a definition of dissolved being that given in the publication "*methods for chemical analysis of water and waste of the U.S. environmental protection agency*," with the exception that standards for mercury, organic compounds and non-aqueous phase liquids shall apply to the total unfiltered concentrations of the contaminants.

A. **Human Health Standards**-Ground water shall meet the standards of Subsection A and B of this section unless otherwise provided. If more than one water contaminant affecting human health is present, the toxic pollutant criteria as set forth in the definition of toxic pollutant in Section 20.6.2.1101 NMAC for the combination of contaminants, or the Human Health Standard of Subsection A of Section 20.6.2.3103 NMAC for each contaminant shall apply, whichever is more stringent. Non-aqueous phase liquid shall not be present floating atop of or immersed within ground water, as can be reasonably measured.

(1) Arsenic (As)....0.1 mg/l
(2) Barium (Ba)....1.0 mg/l
(3) Cadmium (Cd)....0.01 mg/l
(4) Chromium (Cr)....0.05 mg/l
(5) Cyanide (CN)....0.2 mg/l
(6) Fluoride (F)....1.6 mg/l
(7) Lead (Pb)....0.05 mg/l
(8) Total Mercury (Hg)....0.002 mg/l
(9) Nitrate (NO_3 as N)....10.0 mg/l
(10) Selenium (Se)....0.05 mg/l
(11) Silver (Ag)....0.05 mg/l
(12) Uranium (U)....0.03 mg/l
(13) Radioactivity: Combined Radium-226 & Radium-228....30 pCi/l
(14) Benzene....0.01 mg/l
(15) Polychlorinated biphenyls (PCB's)....0.001 mg/l
(16) Toluene....0.75 mg/l
(17) Carbon Tetrachloride....0.01 mg/l
(18) 1,2-dichloroethane (EDC)....0.01 mg/l
(19) 1,1-dichloroethylene (1,1-DCE)....0.005 mg/l
(20) 1,1,2,2-tetrachloroethylene (PCE)....0.02 mg/l
(21) 1,1,2-trichloroethylene (TCE)....0.1 mg/l
(22) ethylbenzene....0.75 mg/l
(23) total xylenes....0.62 mg/l
(24) methylene chloride....0.1 mg/l
(25) chloroform....0.1 mg/l
(26) 1,1-dichloroethane....0.025 mg/l
(27) ethylene dibromide (EDB)....0.0001 mg/l
(28) 1,1,1-trichloroethane....0.06 mg/l
(29) 1,1,2-trichloroethane....0.01 mg/l
(30) 1,1,2,2-tetrachloroethane....0.01 mg/l
(31) vinyl chloride....0.001 mg/l

(32) PAHs: total naphthalene plus monomethylnaphthalenes....................0.03 mg/l

(33) benzo-a-pyrene..0.0007 mg/l

B. Other Standards for Domestic Water Supply

(1) Chloride (Cl) ....250.0 mg/l

(2) Copper (Cu) ....1.0 mg/l

(3) Iron (Fe) ....1.0 mg/l

(4) Manganese (Mn) ....0.2 mg/l

(6) Phenols...0.005 mg/l

(7) Sulfate (SO_4) ....600.0 mg/l

(8) Total Dissolved Solids (TDS) ....1000.0 mg/l

(9) Zinc (Zn) ....10.0 mg/l

(10) pH...between 6 and 9

C. Standards for Irrigation Use - Ground water shall meet the standards of Subsection A, B, and C of this section unless otherwise provided.

(1) Aluminum (Al)...5.0 mg/l

(2) Boron (B) ....0.75 mg/l

(3) Cobalt (Co) ....0.05 mg/l

(4) Molybdenum (Mo) ....1.0 mg/l

(5) Nickel (Ni) ....0.2 mg/l

[2-18-77, 1-29-82, 11-17-83, 3-3-86, 12-1-95; 20.6.2.3103 NMAC - Rn, 20 NMAC 6.2.III.3103, 1-15-01; A, 9-26-04]

[Note: For purposes of application of the amended numeric uranium standard to past and current water discharges (as of 9-26-04), the new standard will not become effective until June 1, 2007. For any new water discharges, the uranium standard is effective 9-26-04.]

20.6.2.3104 DISCHARGE PERMIT REQUIRED: Unless otherwise provided by this Part, no person shall cause or allow effluent or leachate to discharge so that it may move directly of indirectly into ground water unless he is discharging pursuant to a discharge permit issued by the secretary. When a permit has been issued, discharges must be consistent with the terms and conditions of the permit. In the event of a transfer of the ownership, control, or possession of a facility for which a discharge permit is in effect, the transferee shall have authority to discharge under such permit, provided that the transferee has complied with Section 20.6.2.3111 NMAC, regarding transfers.
[2-18-77, 12-24-87, 12-1-95; Rn & A, 20.6.2.3104 NMAC - 20 NMAC 6.2.III.3104, 1-15-01; A, 12-1-01]

20.6.2.3105 EXEMPTIONS FROM DISCHARGE PERMIT REQUIREMENT: Sections 20.6.2.3104 and 20.6.2.3106 NMAC do not apply to the following:

A. Effluent or leachate which conforms to all the listed numerical standards of Section 20.6.2.3103 NMAC and has a total nitrogen concentration of 10 mg/l or less, and does not contain any toxic pollutant. To determine conformance, samples may be taken by the agency before the effluent or leachate is discharged so that it may move directly or indirectly into ground water; provided that if the discharge is by seepage through non-natural or altered natural materials, the agency may take samples of the solution before or after seepage. If for any reason the agency does not have access to obtain the appropriate samples, this exemption shall not apply;

B. Effluent which is discharged from a sewerage system used only for disposal of household and other domestic waste which is designed to receive and which receives 2,000 gallons or less of liquid waste per day;

C. Water used for irrigated agriculture, for watering of lawns, trees, gardens or shrubs, or for irrigation for a period not to exceed five years for the revegetation of any disturbed land area, unless that water is received directly from any sewerage system;

D. Discharges resulting from the transport or storage of water diverted, provided that the water diverted has not had added to it after the point of diversion any effluent received from a sewerage system, that the source of the water diverted was not mine workings, and that the secretary has not determined that a hazard to public health may result;

E. Effluent which is discharged to a watercourse which is naturally perennial; discharges to dry arroyos and ephemeral streams are not exempt from the discharge permit requirement, except as otherwise provided in this section;

F. Those constituents which are subject to effective and enforceable effluent limitations in a National Pollutant Discharge Elimination System (NPDES) permit, where discharge onto or below the surface of the ground so that water contaminants may move directly or indirectly into ground water occurs downstream from the outfall

2006 ANNUAL MONITORING REPORT / PERFORMANCE REVIEW
FOR
HOMESTAKE'S GRANTS PROJECT
PURSUANT TO
NRC LICENSE SUA-1471 AND DISCHARGE PLAN DP-200

FOR:

U.S. NUCLEAR REGULATORY COMMISSION
AND
NEW MEXICO ENVIRONMENT DEPARTMENT

BY:

HOMESTAKE MINING COMPANY OF CALIFORNIA
GRANTS, NEW MEXICO

AND

HYDRO-ENGINEERING, LLC
CASPER, WYOMING

MARCH, 2007

George L Hoffman

GEORGE L. HOFFMAN, P.E.
5831 N.M. HYDROLOGIST

3/26/07

1.0 EXECUTIVE SUMMARY AND INTRODUCTION

1.1 EXECUTIVE SUMMARY

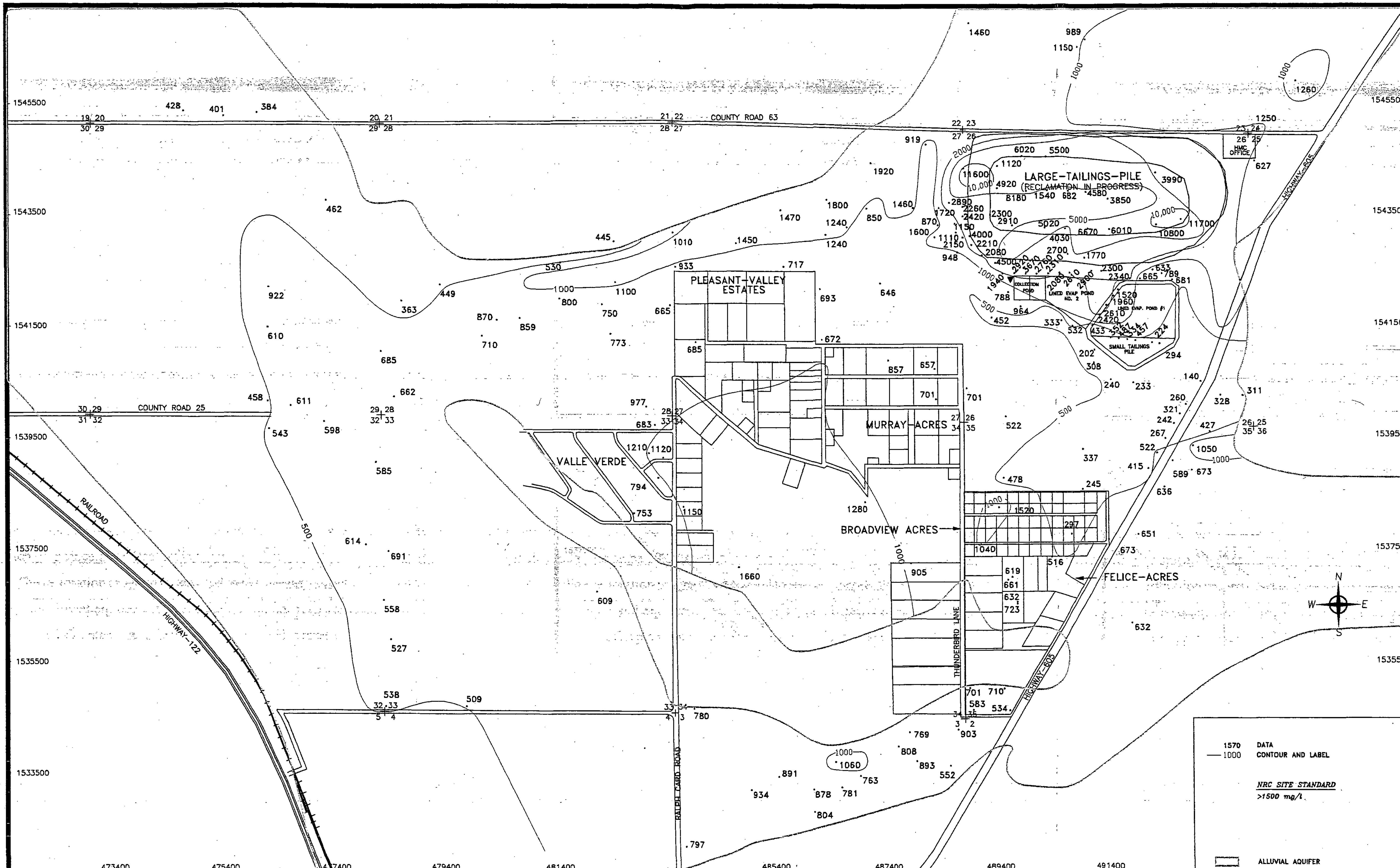
Homestake Mining Company of California manages a ground water restoration program as defined by Nuclear Regulatory Commission (NRC) License SUA-1471, and New Mexico Environment Department (NMED), DP-200 permit. The restoration program is a dynamic on-going strategy based on a restoration plan, which began in 1977, and is scheduled to be completed in 2015. Additional evaluation of the ground water restoration has extended the end of the program to 2015 from 2011.

Homestake's long-term goal is to restore the ground water aquifer to levels as close as practicable to the up-gradient background levels. A ground water collection area (see shaded area on Figure 2.1-1, Page 2.1-11) has been established and is bounded by a down-gradient perimeter of injection/infiltration wells and trenches. Alluvial ground water that flows beneath the tailings enters this collection area. All ground water in the alluvial aquifer that is within the collection area is eventually captured by the collection well system. Once ground water quality restoration within the zone is complete and approved by the agencies, the site is to be transferred to the U.S. Department of Energy, which will have the responsibility for long-term site care and maintenance.

The data reported within this document represent the results of the monitoring program during 2006. This is a yearly reporting requirement. A similar report has been submitted to the agencies each year since 1983 (see list in Section 1.2).

The restoration program is designed to remove target contaminants from the ground water by flushing the alluvial aquifer with deep-well supplied fresh water or water produced from the reverse osmosis (R.O.) plant. A series of collection wells is used to collect the contaminated water, which is pumped to the R.O. plant for treatment or, alternatively, reported to the evaporation ponds.

Historically, the contaminants are found in two different aquifer systems. The aquifer system of primary concern is the alluvial system, which averages approximately 100 feet in depth, and extends generally north to south encompassing the San Mateo alluvial aquifer. In addition, a second aquifer system is found within the Chinle formation underlying the San Mateo alluvium. It is comprised of three separate aquifers designated as the Upper, Middle and Lower Chinle aquifers. The Hydro-Engineering 2003b report should be reviewed for details of the geologic setting and



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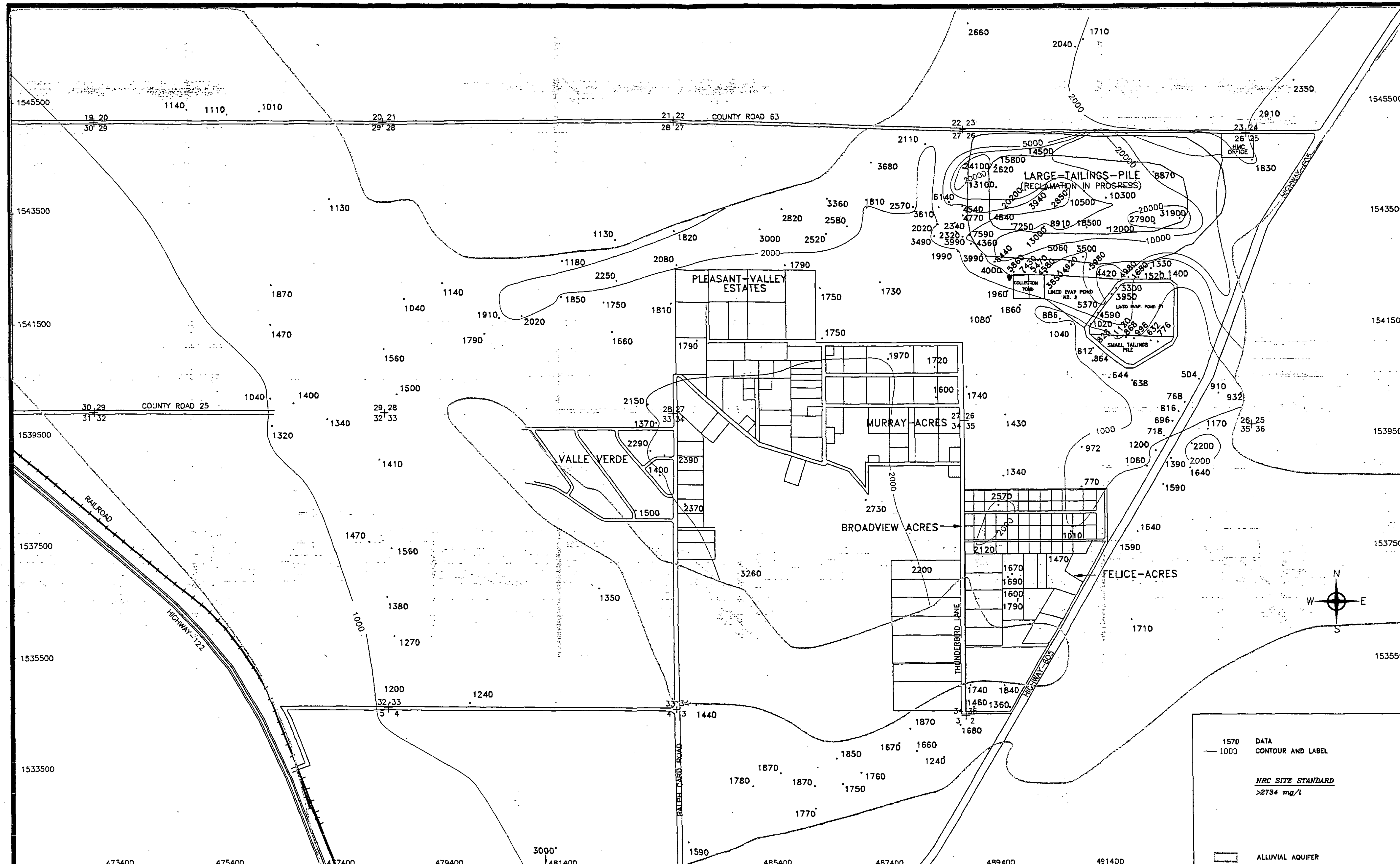
HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-1. SULFATE CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006, mg/l



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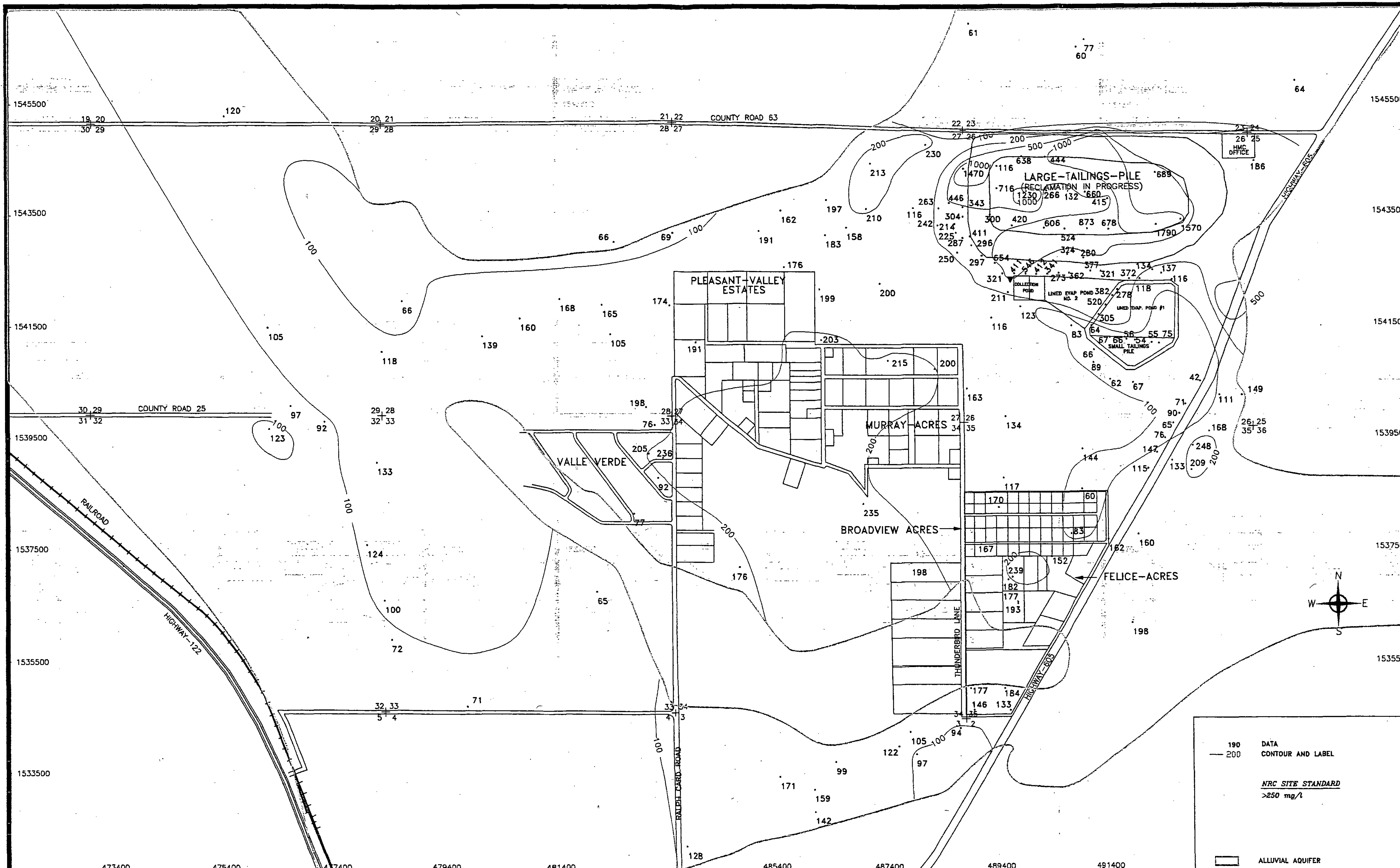
HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-19. TDS CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006, mg/l



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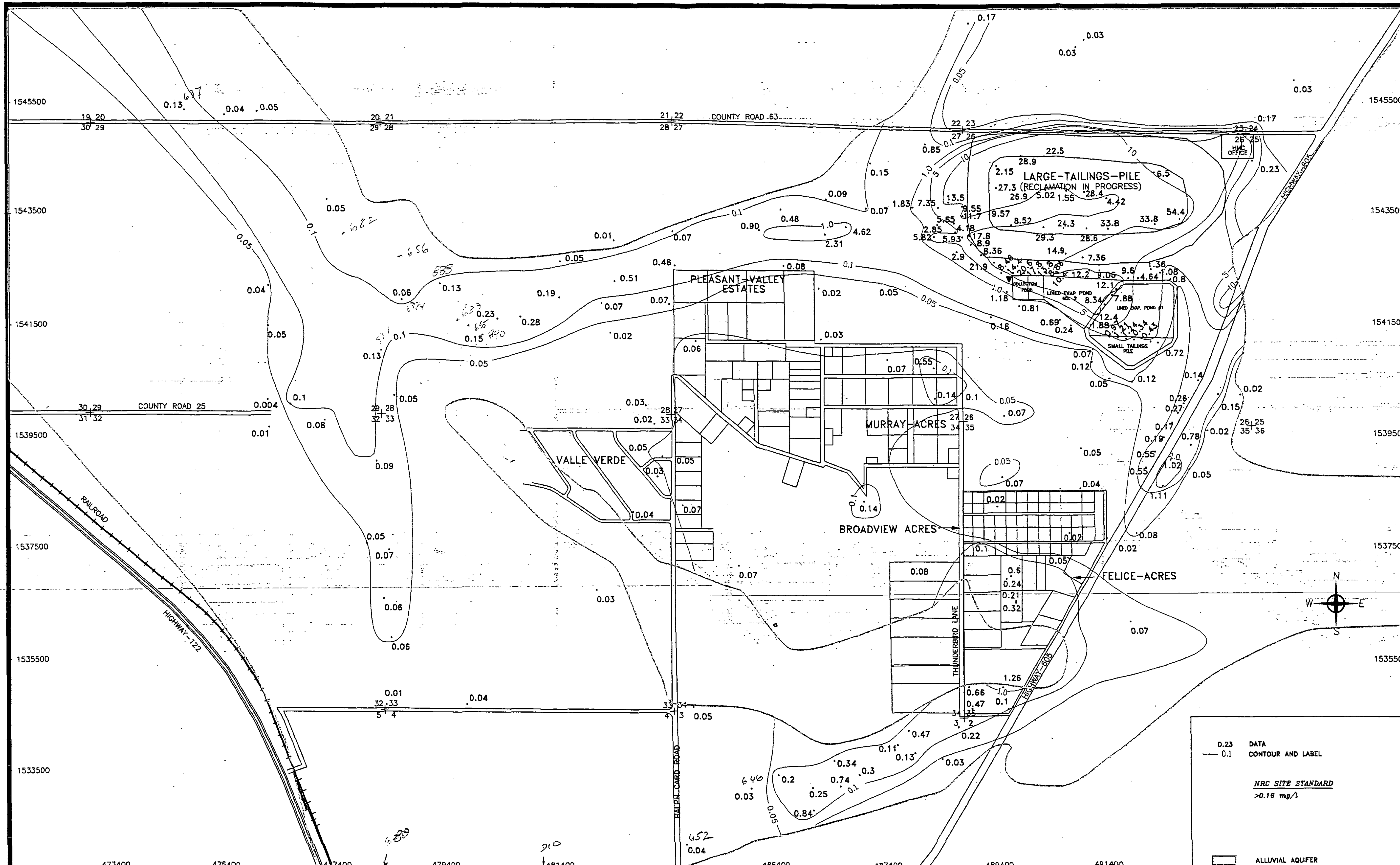
HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-36. CHLORIDE CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006, mg/l



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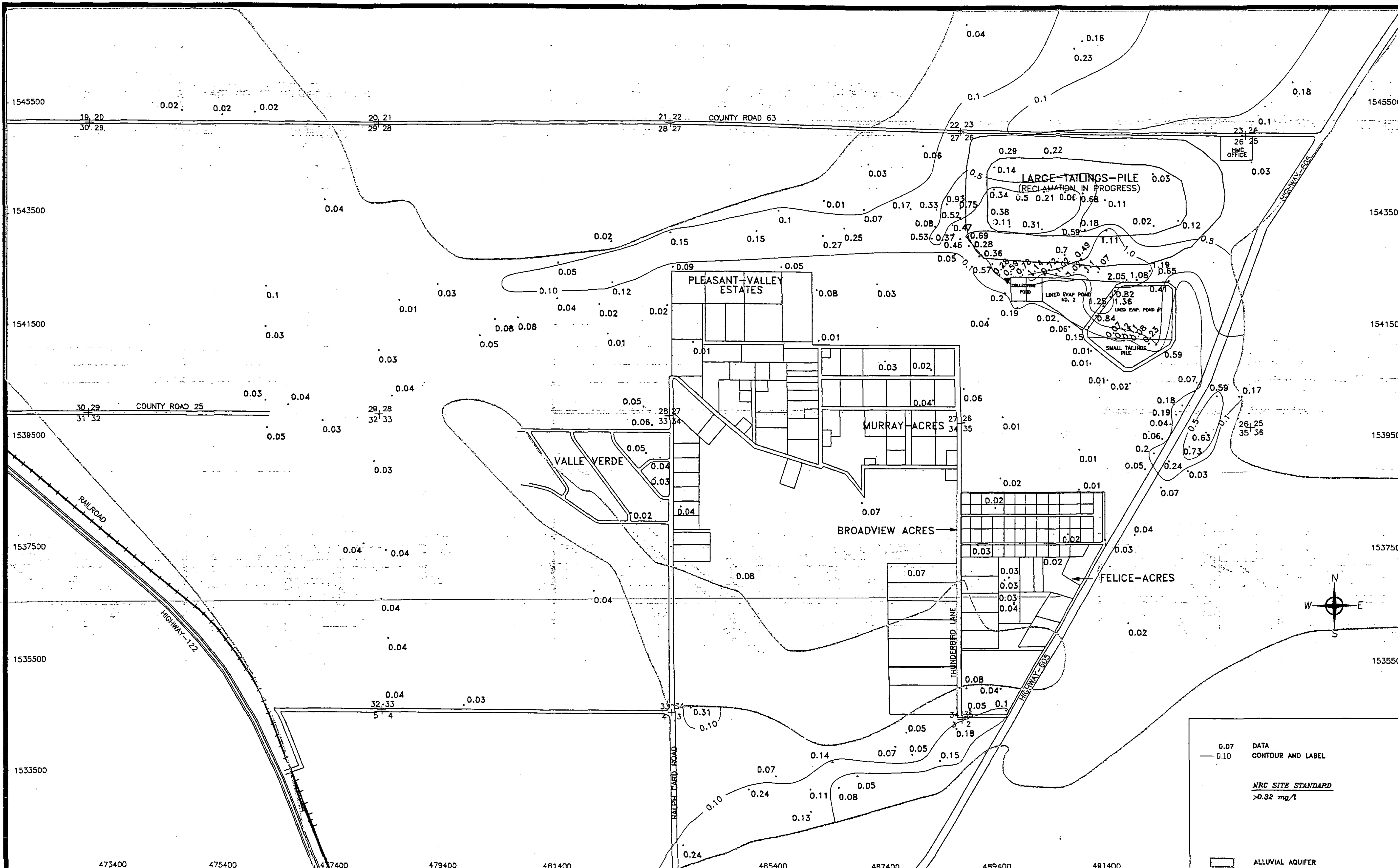
DATE: 03/28/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-53. URANIUM CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006 mg/l



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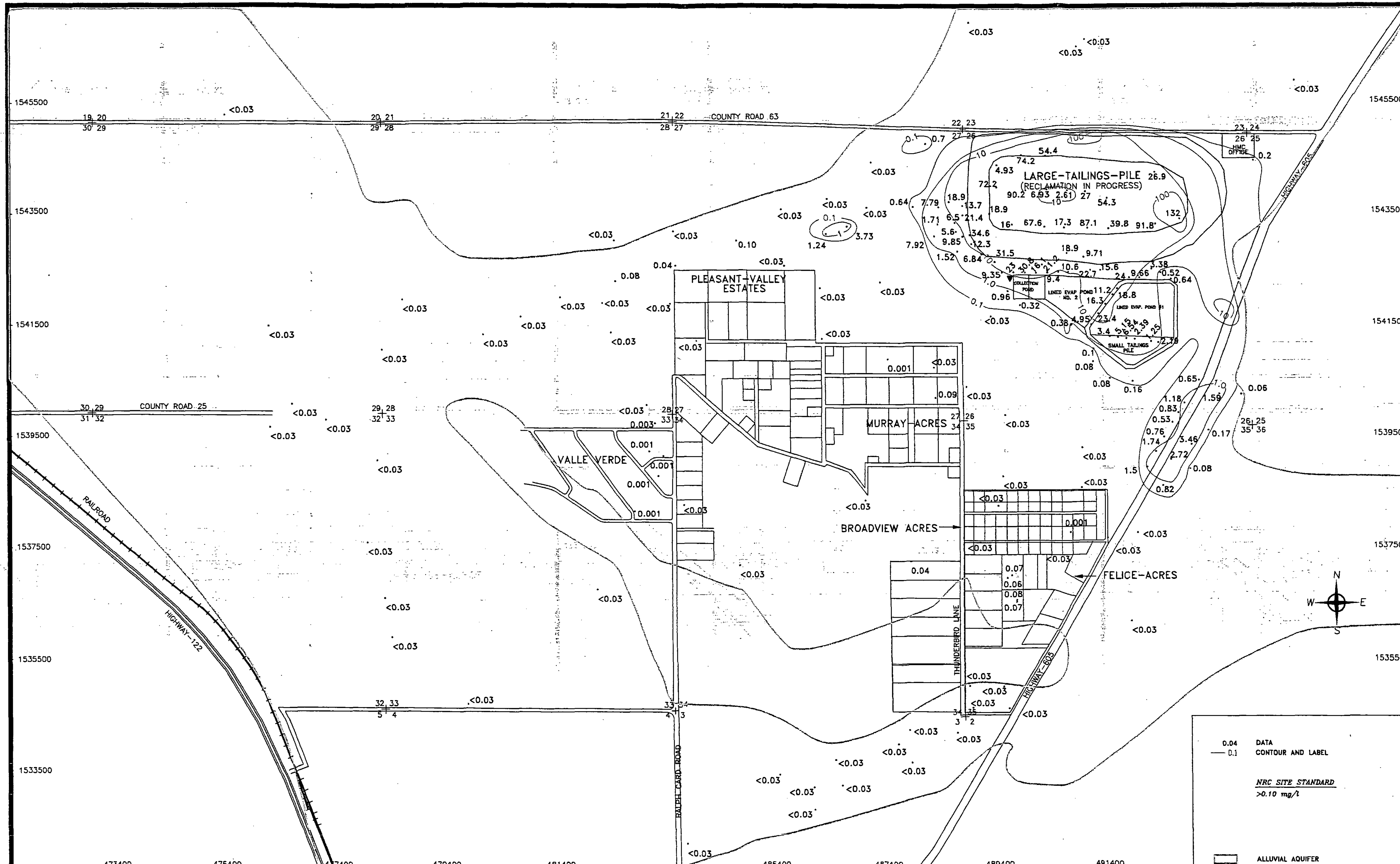
C:\PROJECTS\2007-06\1600QAL --JDF
DATE: 03/28/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-70. SELENIUM CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006, mg/l

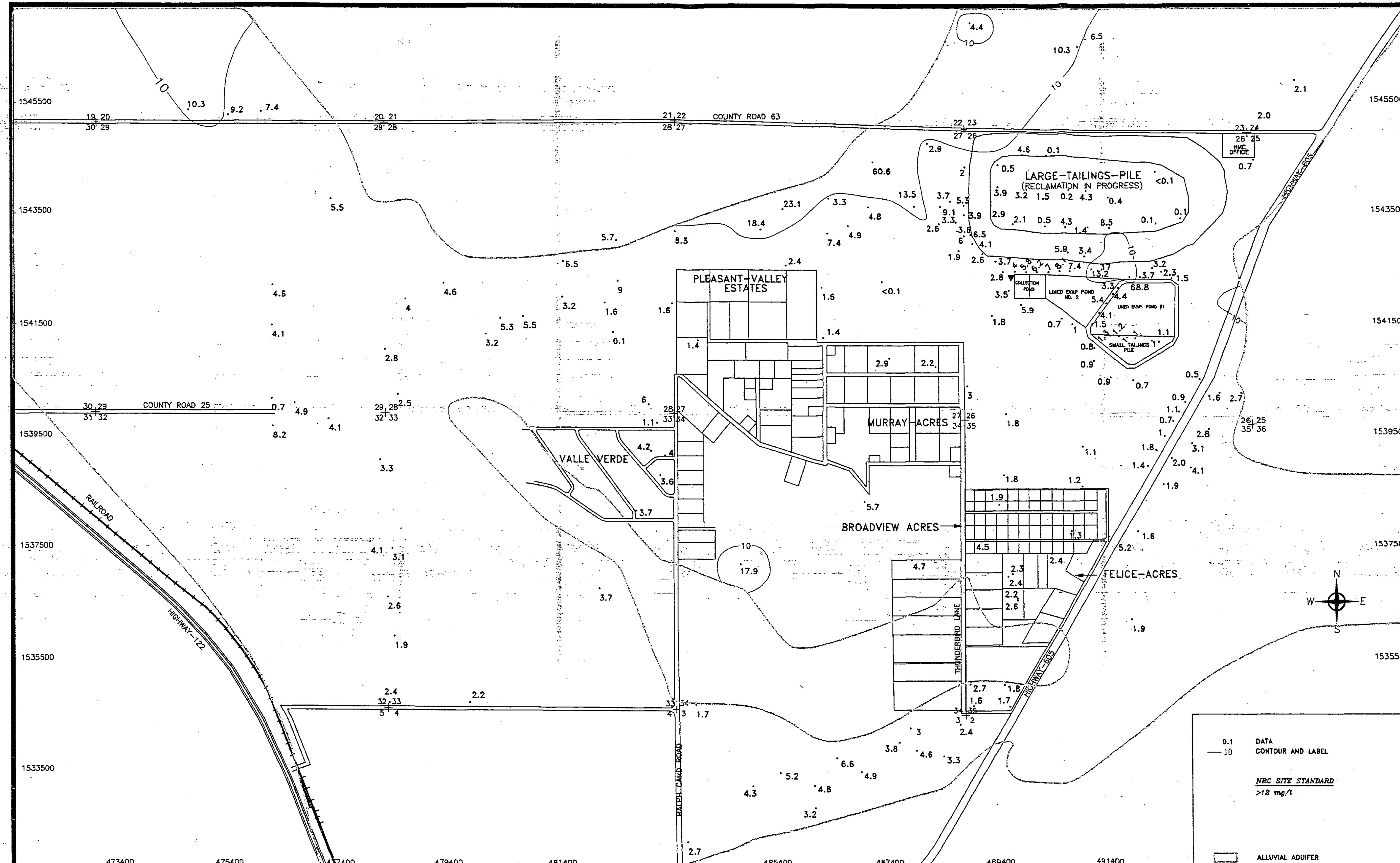


SCALE: 1"=1600'
C:\PROJECTS\ 2007-05\1600QAL --JDF
DATE: 03/28/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-87. MOLYBDENUM CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006, mg/l

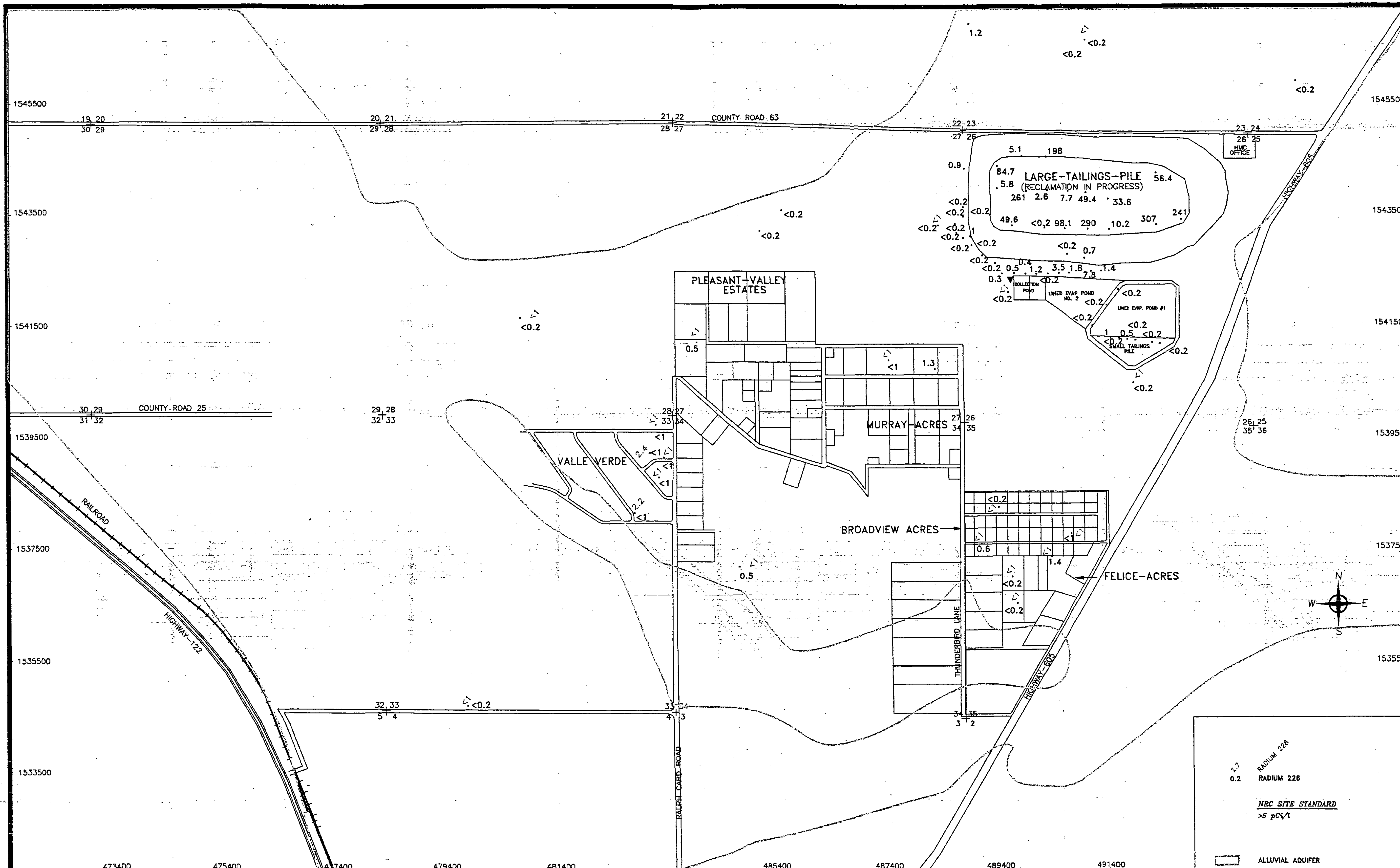


SCALE: 1"=1600'
C:\PROJECTS\2007-06\1600QAL --JDF
DATE: 03/28/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-104. NITRATE CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006, mg/l

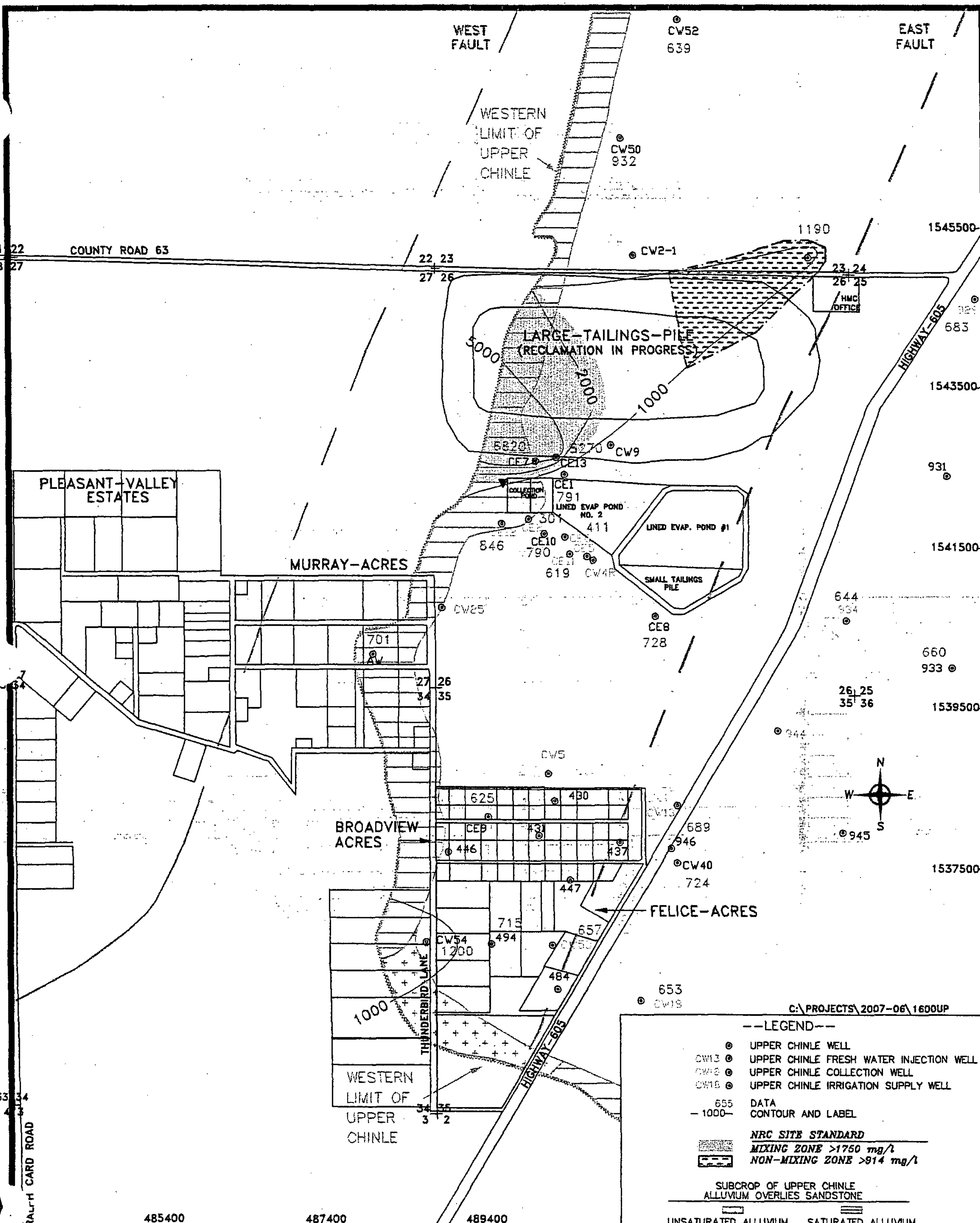


SCALE: 1"=1600'
C:\PROJECTS\2007-06\1600QAL --JDF
DATE: 03/28/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-121. RADIUM-226 AND RADIUM-228 CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2006, pCi/l

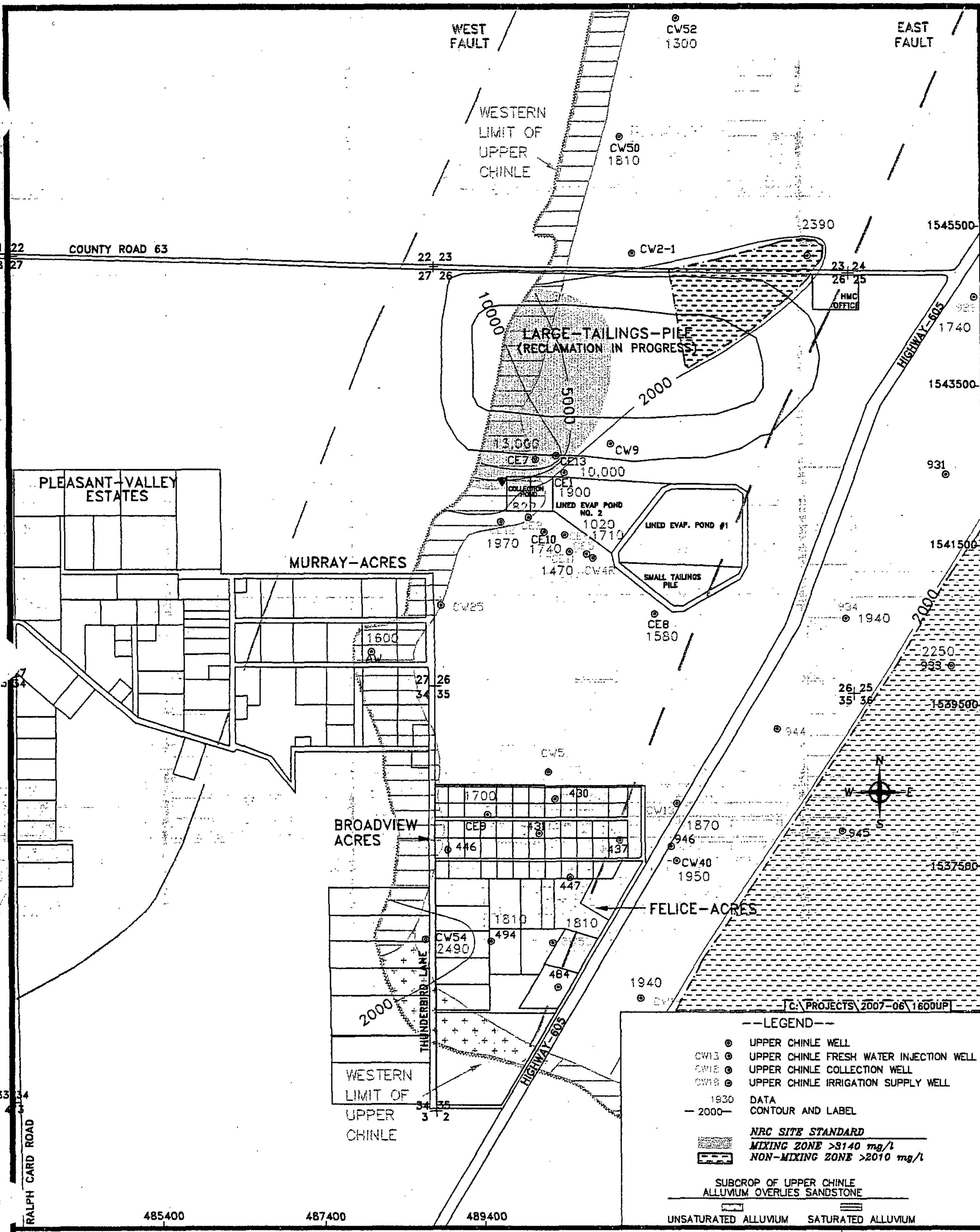


HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W

FIGURE 5.3-1. SULFATE CONCENTRATIONS OF THE UPPER CHINLE AQUIFER, 2006, mg/l

DATE: 03/08/07

SCALE: 1"=1600'

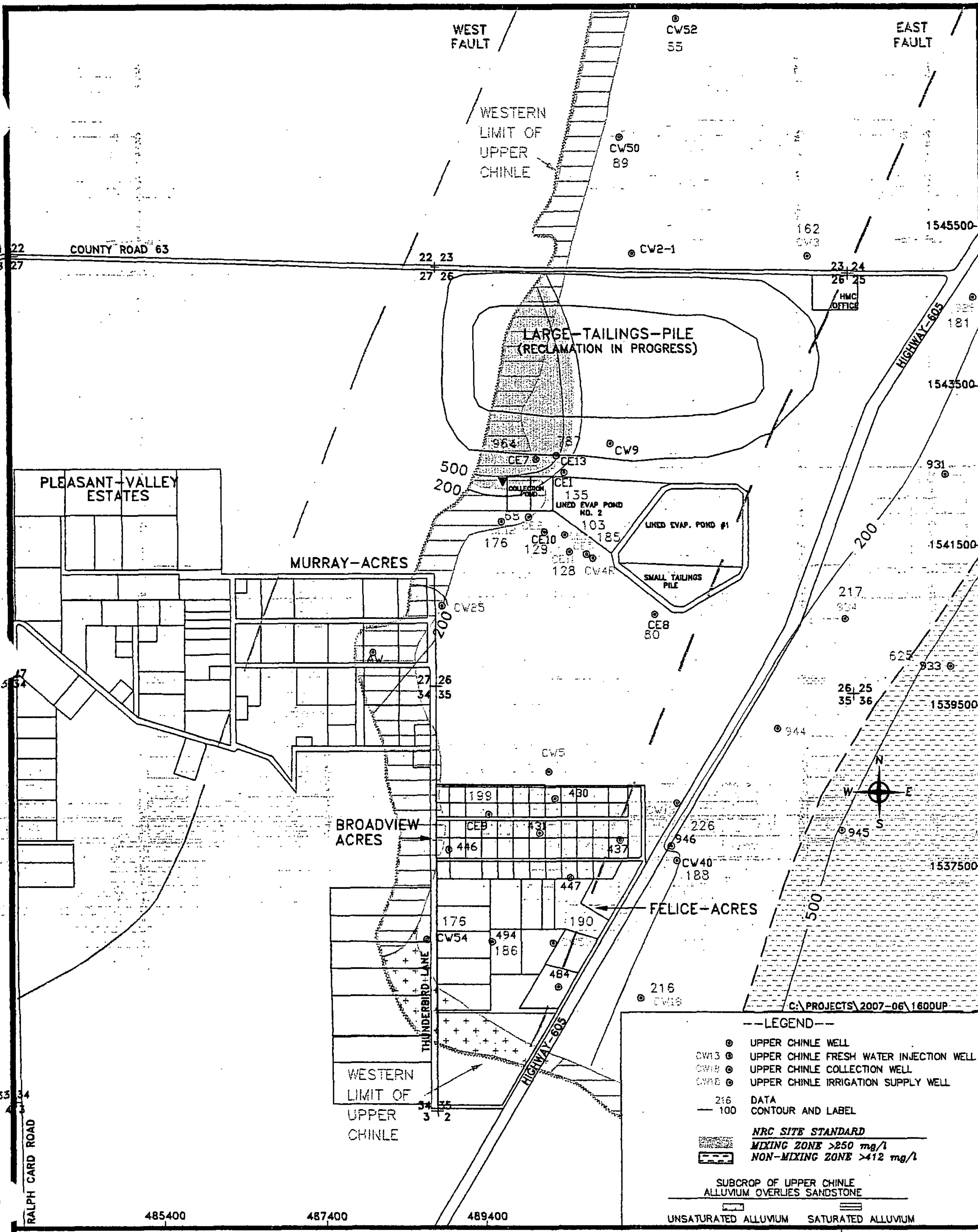


HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W

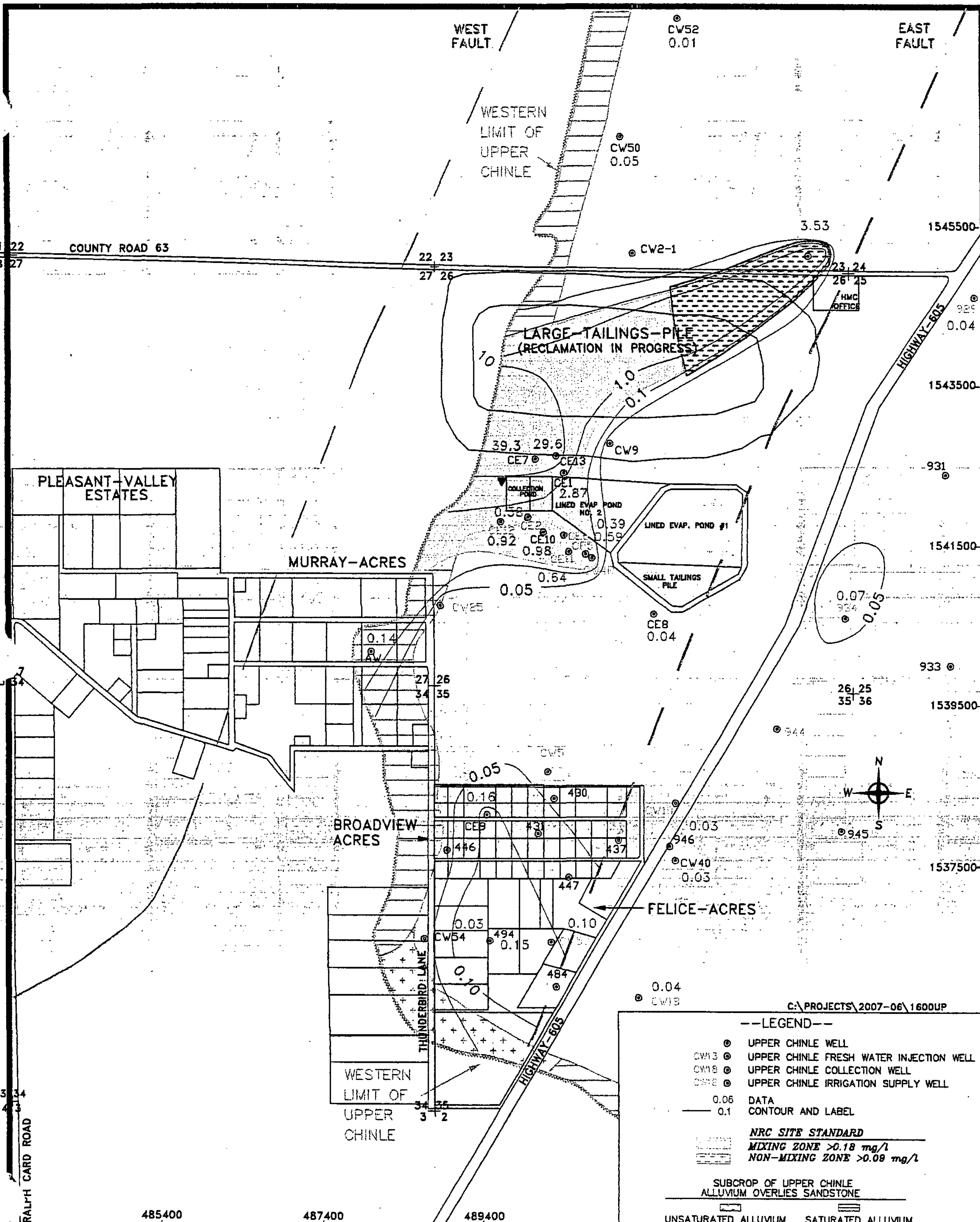
FIGURE 5.3-5. TDS CONCENTRATIONS OF THE UPPER CHINLE AQUIFER, 2006, mg/l

DATE: 03/08/07

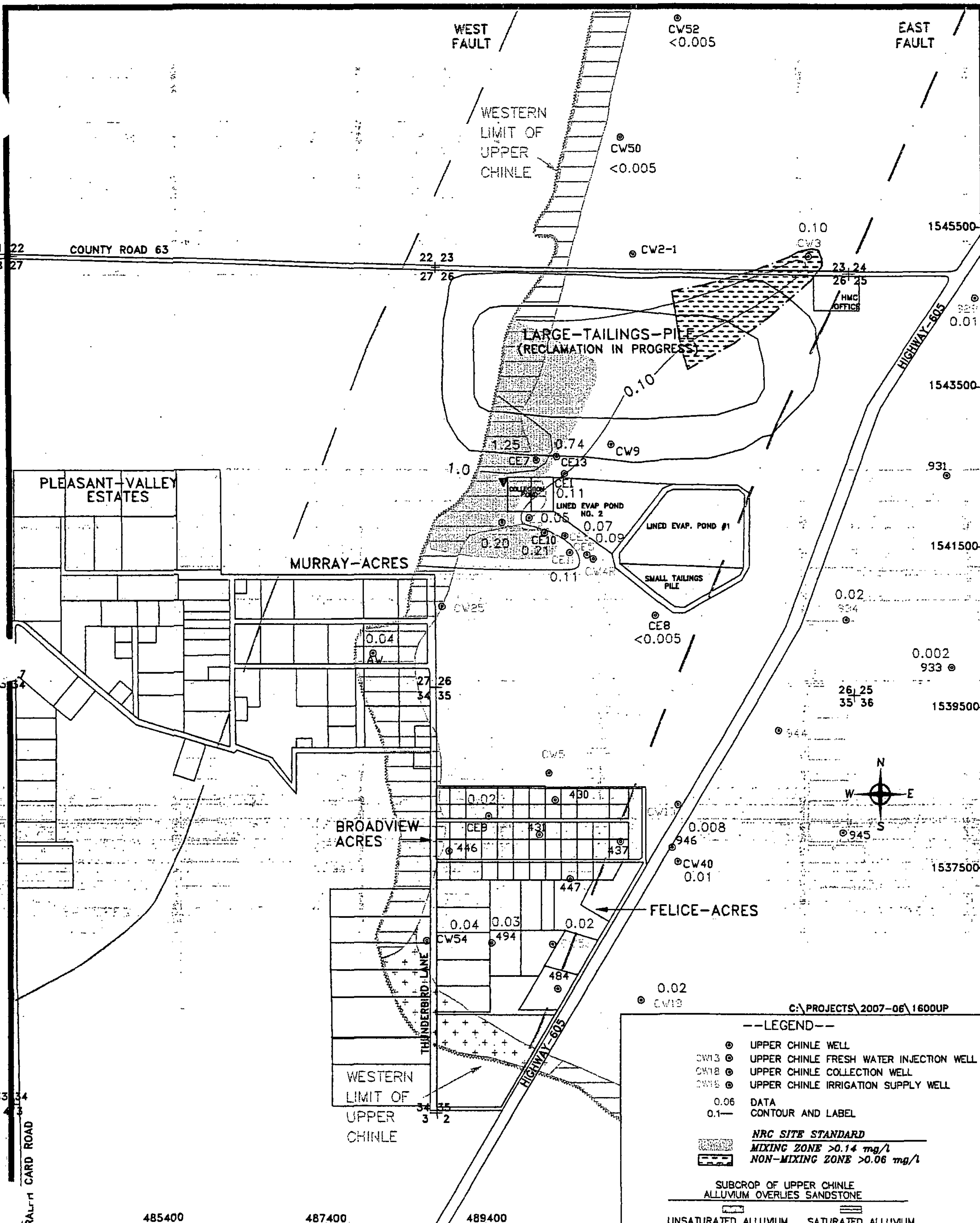
SCALE: 1"=1600'



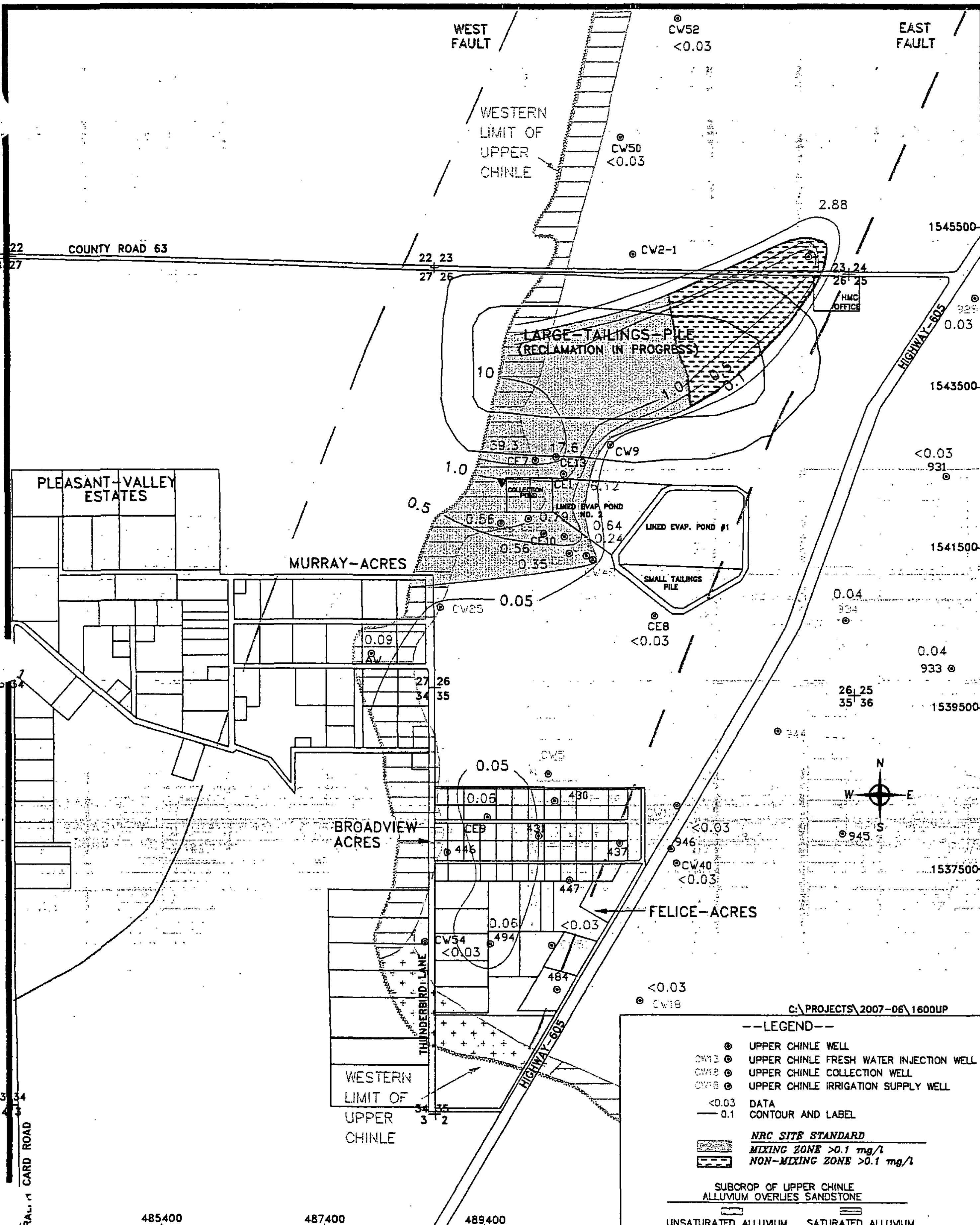
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 5.3-8. CHLORIDE CONCENTRATIONS OF THE UPPER CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 5.3-15



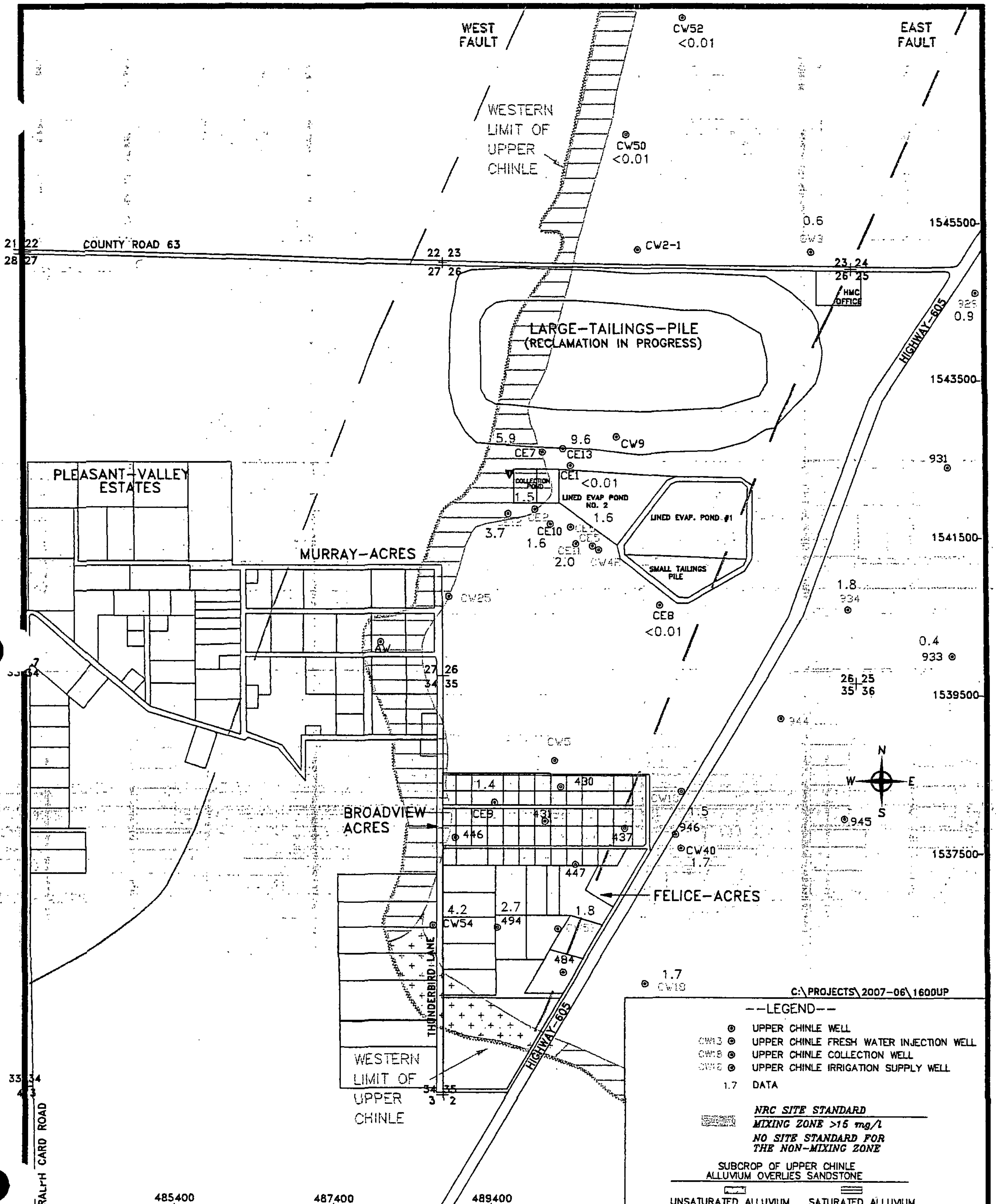
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 5.3-11. URANIUM CONCENTRATIONS OF THE UPPER CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 5.3-18



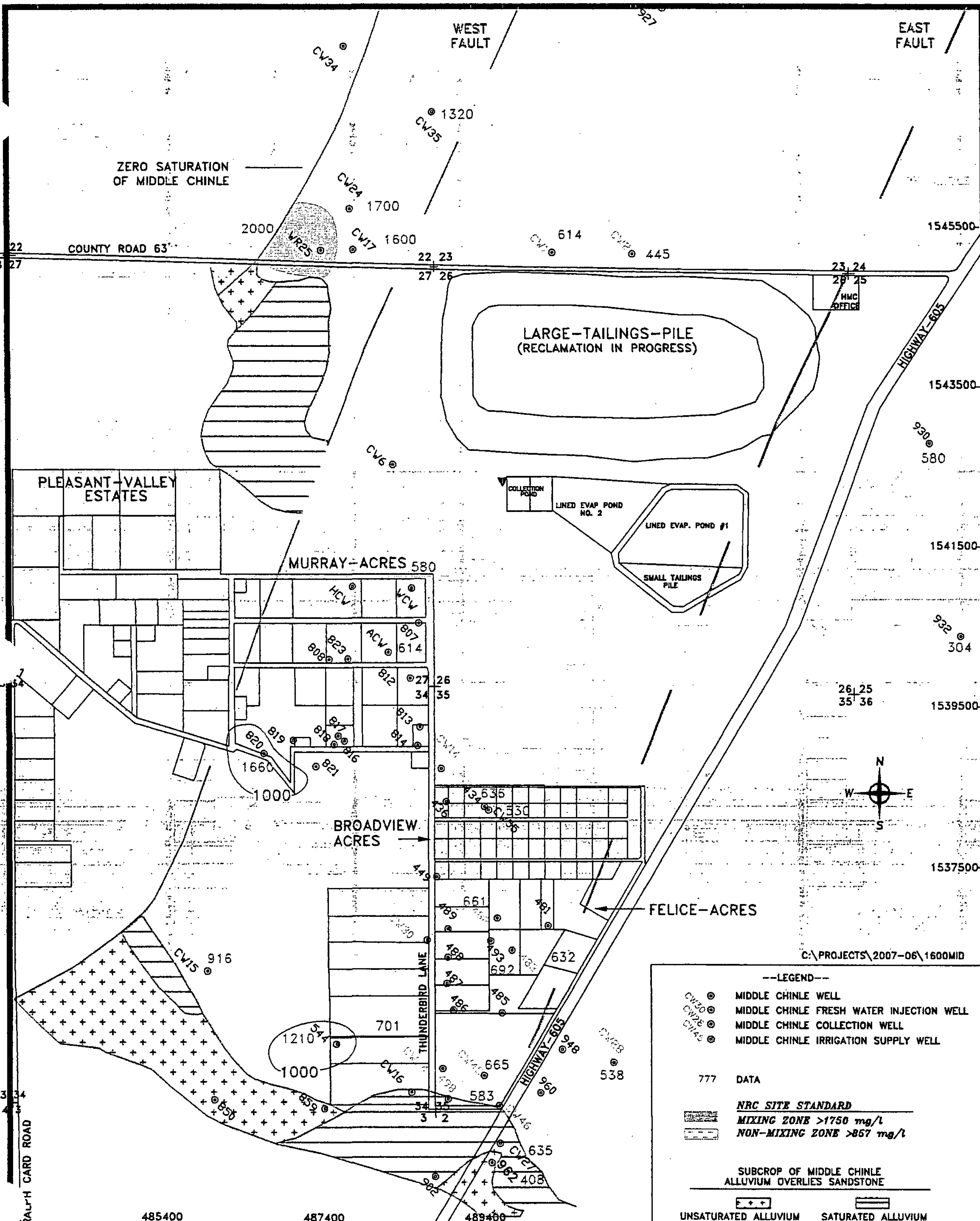
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 5.3-14. SELENIUM CONCENTRATIONS OF THE UPPER CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 5.3-21



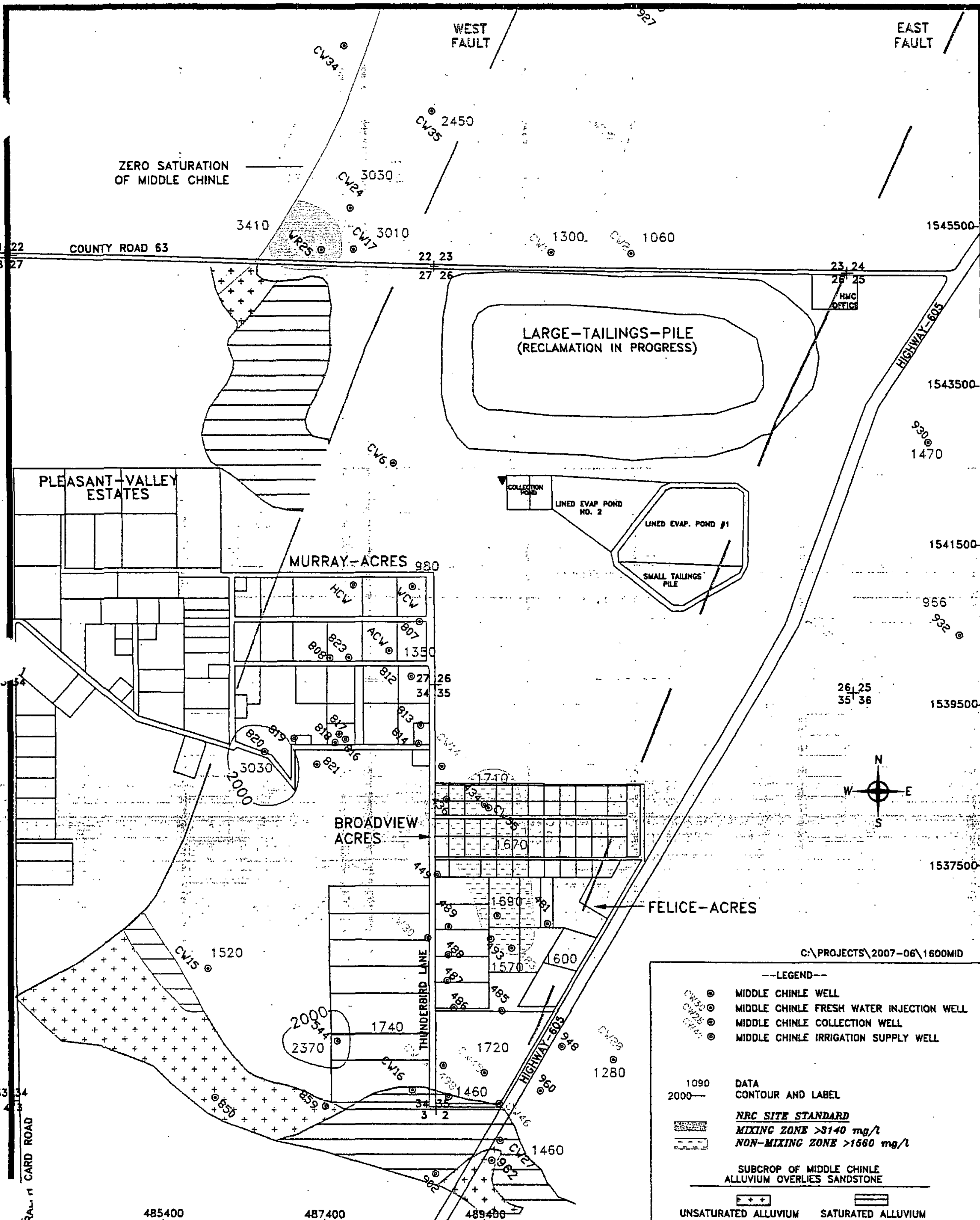
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 5.3-17. MOLYBDENUM CONCENTRATIONS OF THE UPPER CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 5.3-24



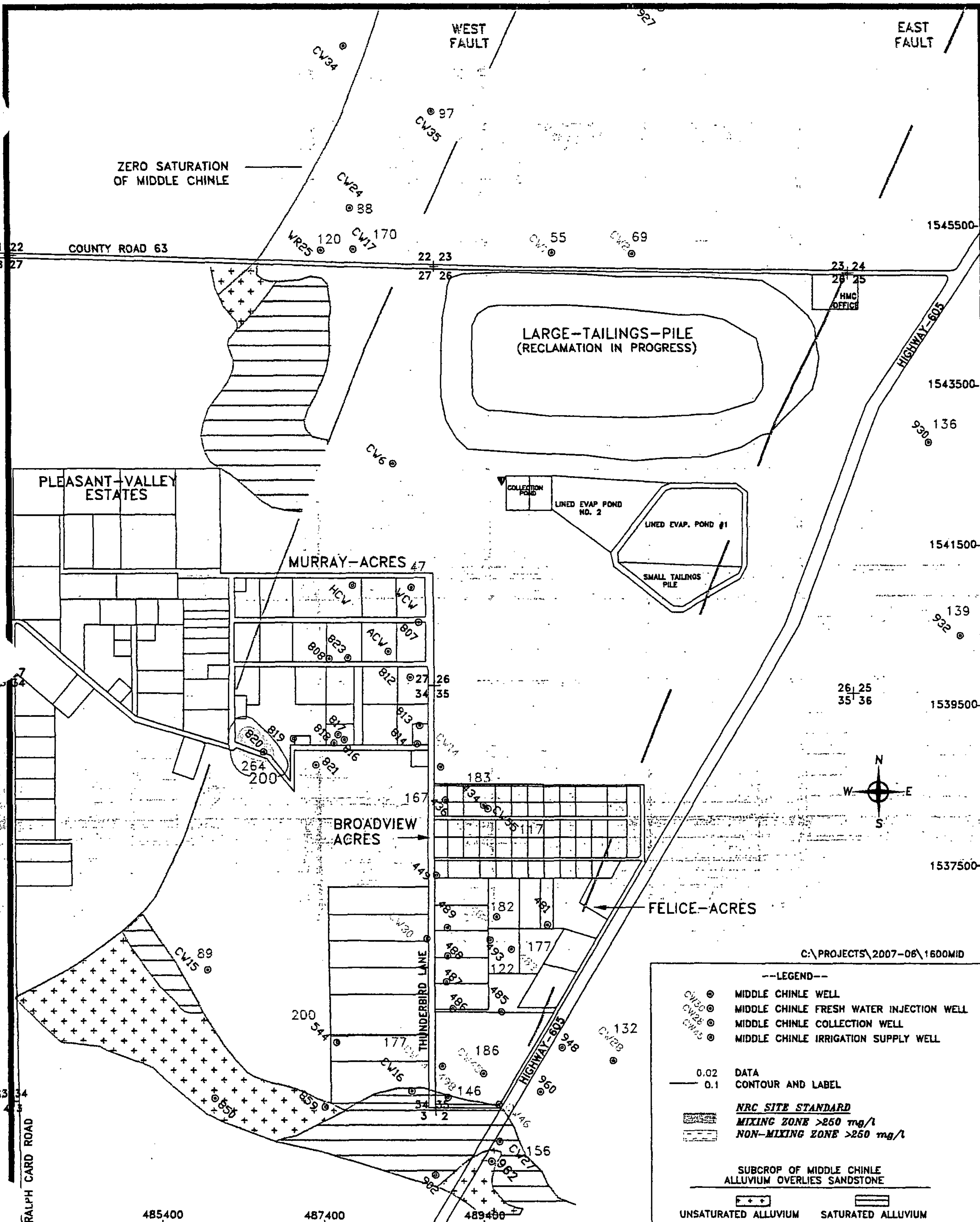
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 5.3-20. NITRATE CONCENTRATIONS OF THE UPPER CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 5.3-27



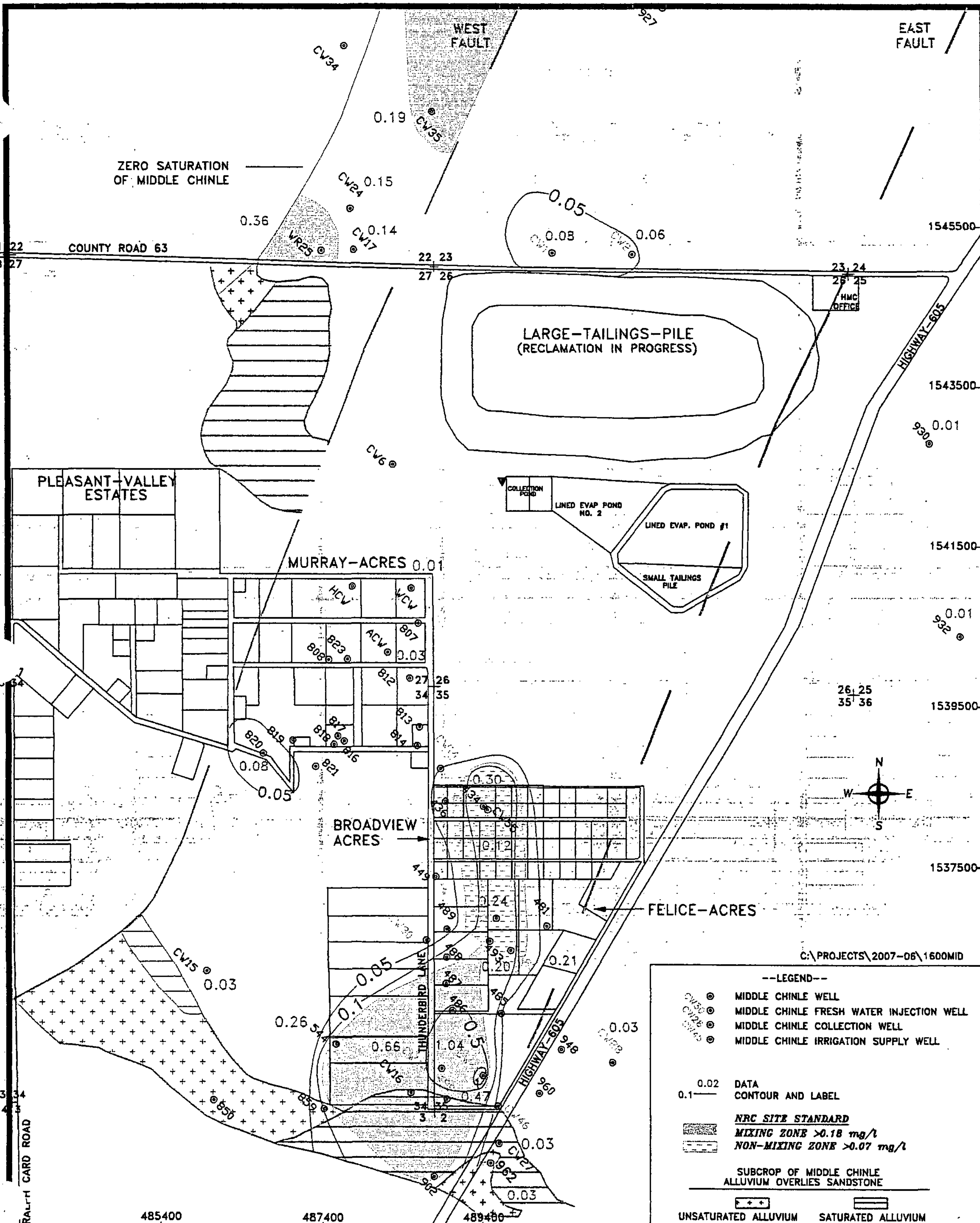
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 6.3-1. SULFATE CONCENTRATIONS OF THE MIDDLE CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 6.3-8



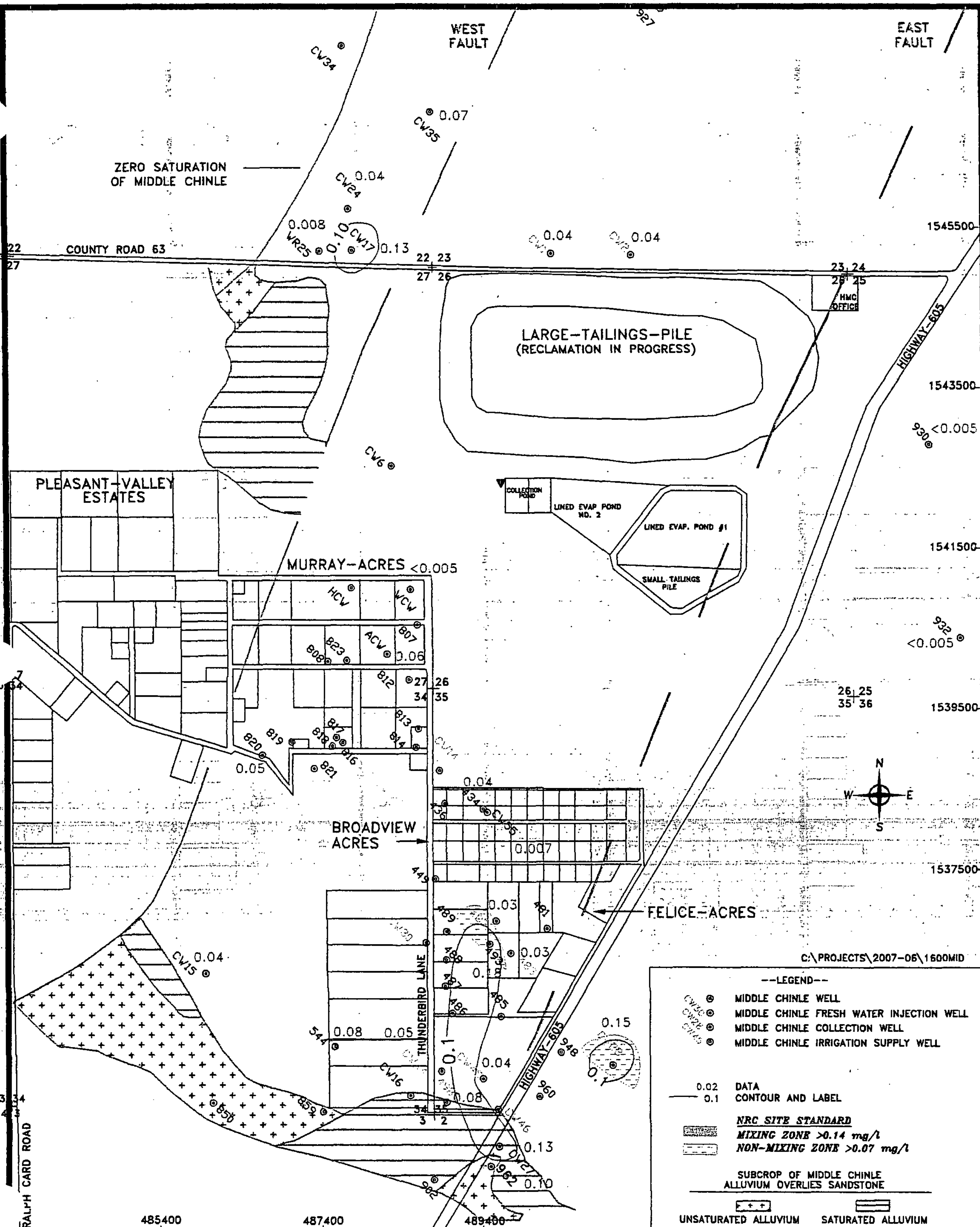
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 6.3-5. TDS CONCENTRATIONS OF THE MIDDLE CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 6.3-12



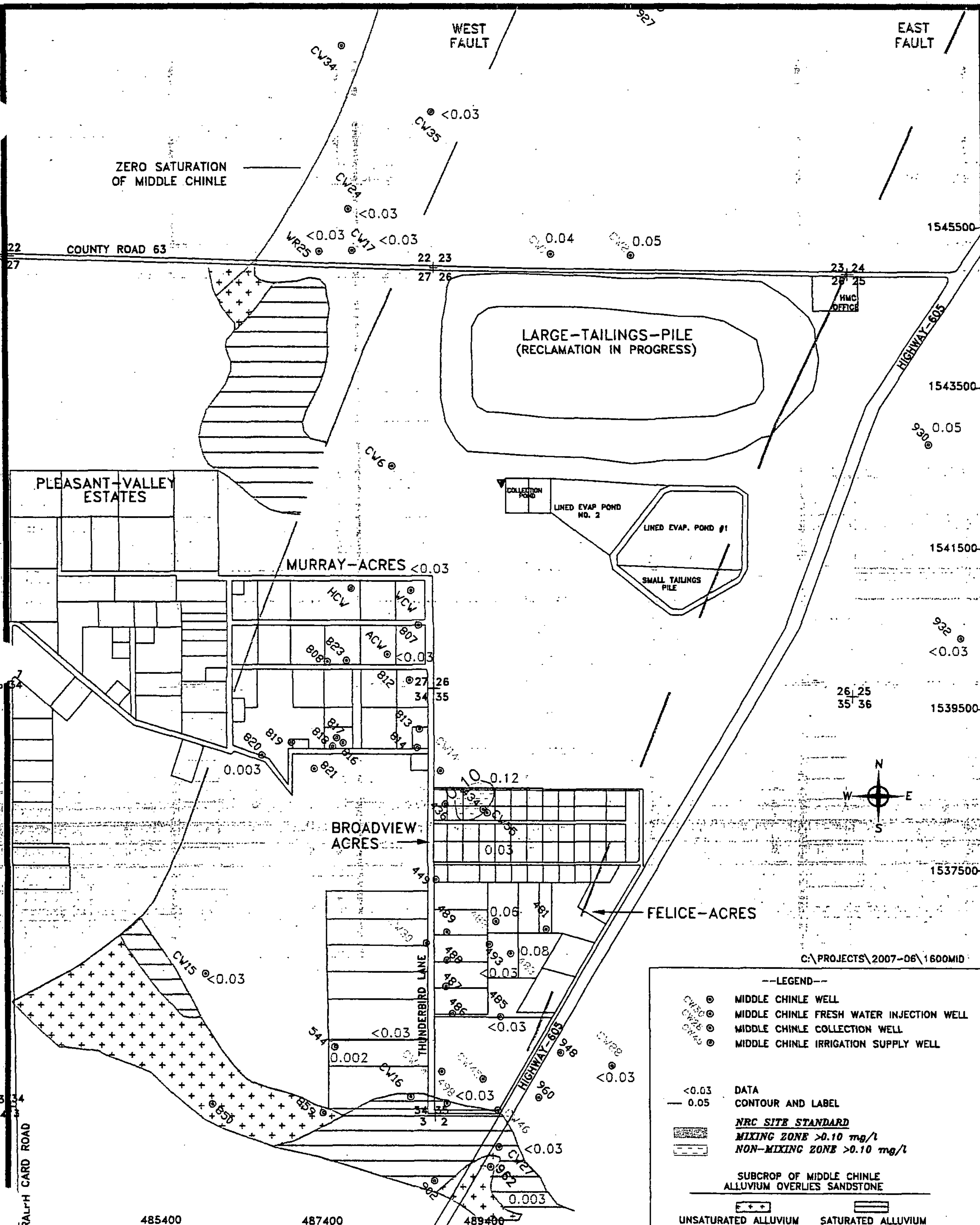
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 6.3-8. CHLORIDE CONCENTRATIONS OF THE MIDDLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 6.3-15



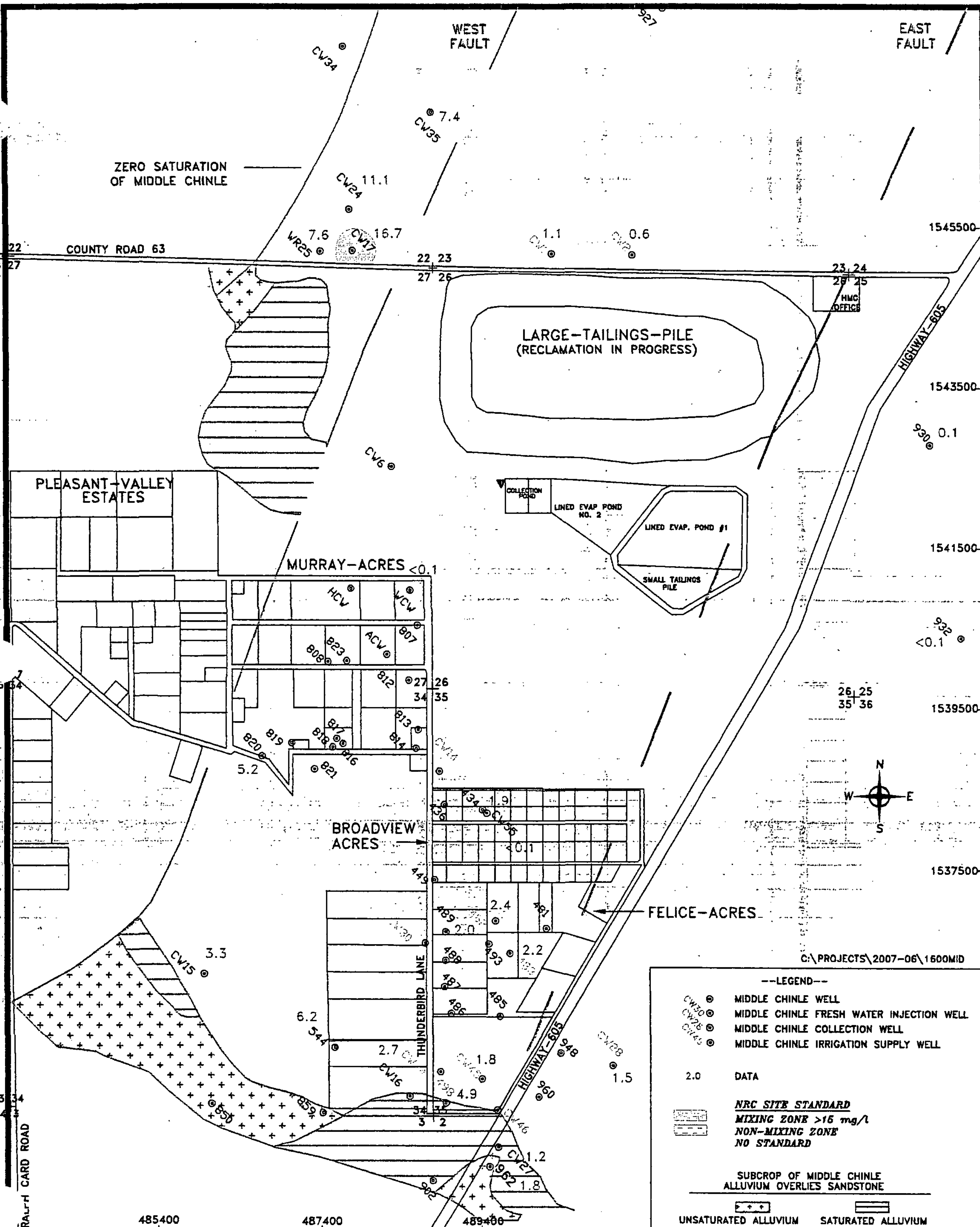
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 6.3-11 URANIUM CONCENTRATIONS OF THE MIDDLE CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 6.3-18



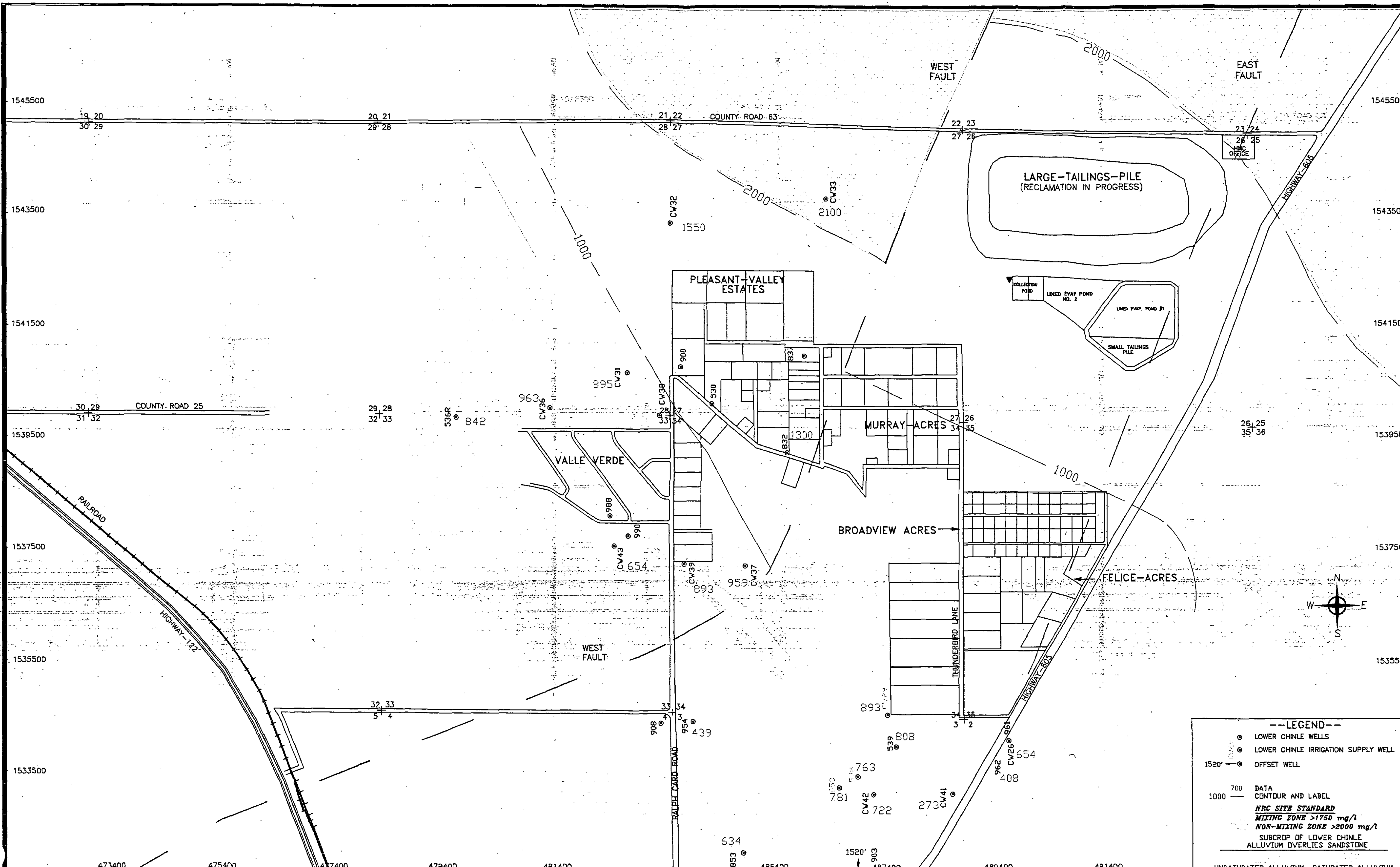
HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 6.3-14. SELENIUM CONCENTRATIONS OF THE MIDDLE CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 6.3-21



HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 6.3-17. MOLYBDENUM CONCENTRATIONS OF THE MIDDLE CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 6.3-24



HOMESTAKE MILL AND ADJACENT PROPERTIES ~ GRANTS, NM ~ TOWNSHIP-11&12N, RANGE-10W	DATE: 03/08/07
FIGURE 6.3-20 NITRATE CONCENTRATIONS OF THE MIDDLE CHINLE AQUIFER, 2006, mg/l	SCALE: 1"=1600'
	PAGE: 6.3-27



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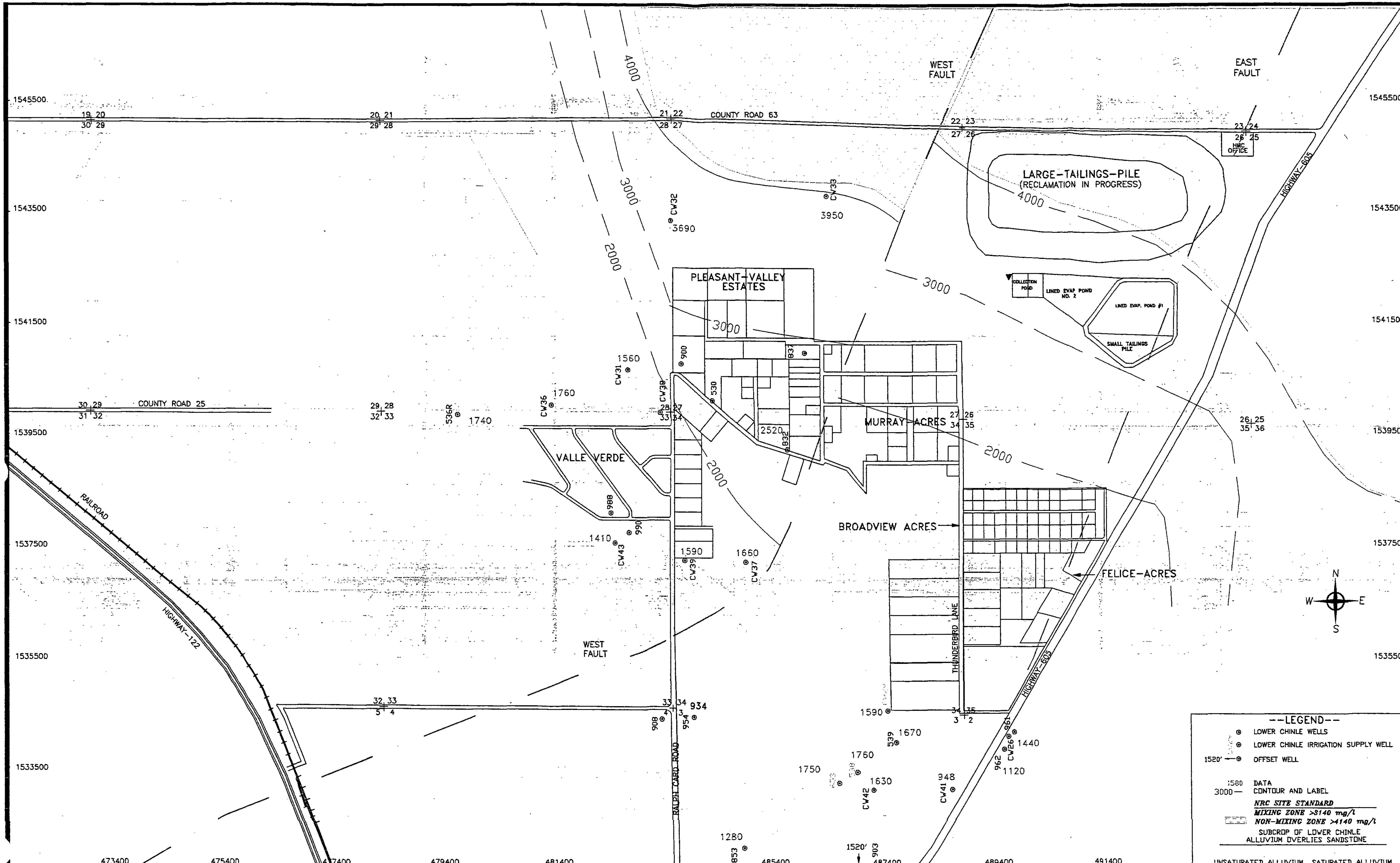
DATE: 03/26/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 7.3-1 SULFATE CONCENTRATIONS OF THE LOWER CHINLE AQUIFER, 2006, mg/l



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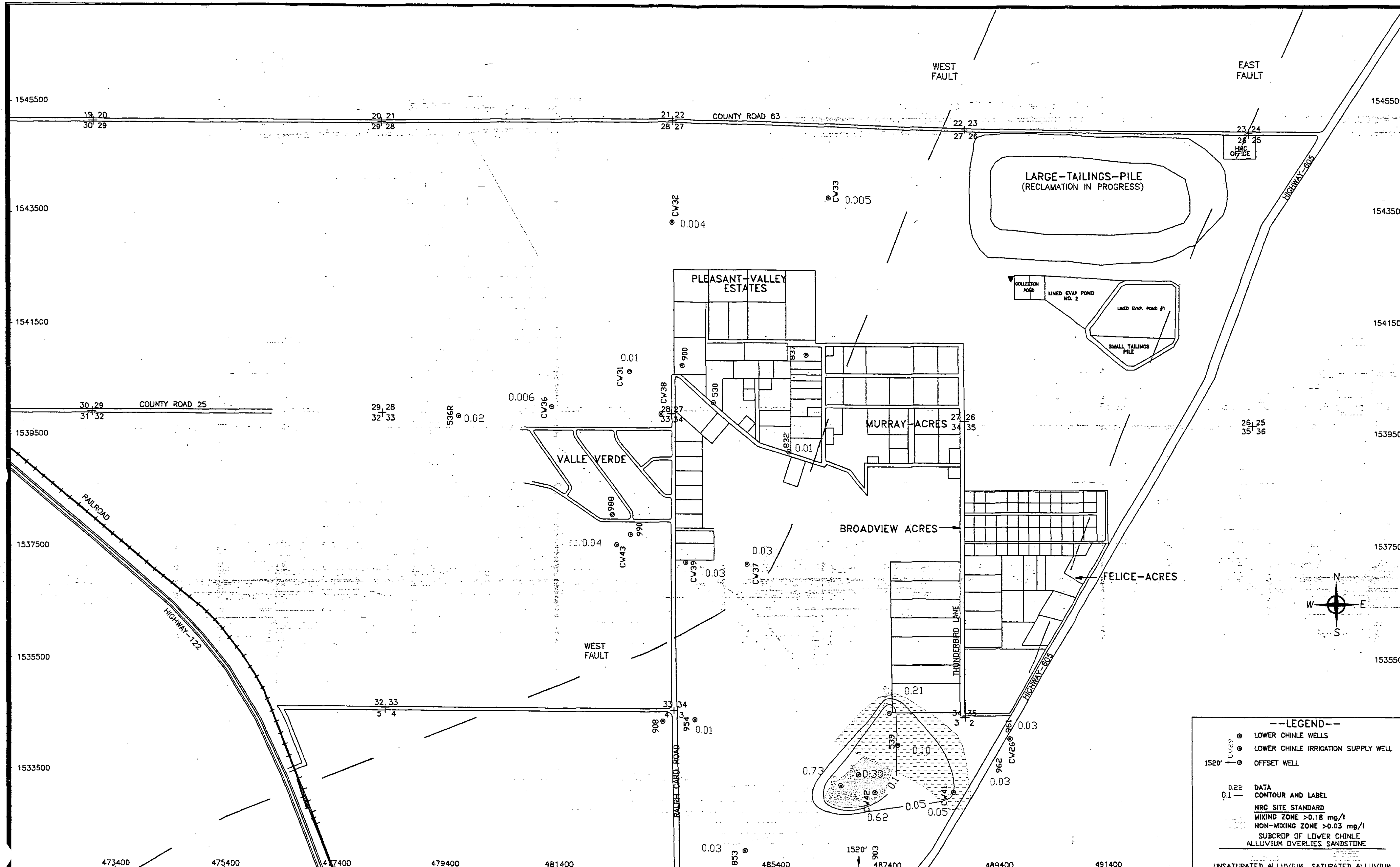
DATE: 03/26/07

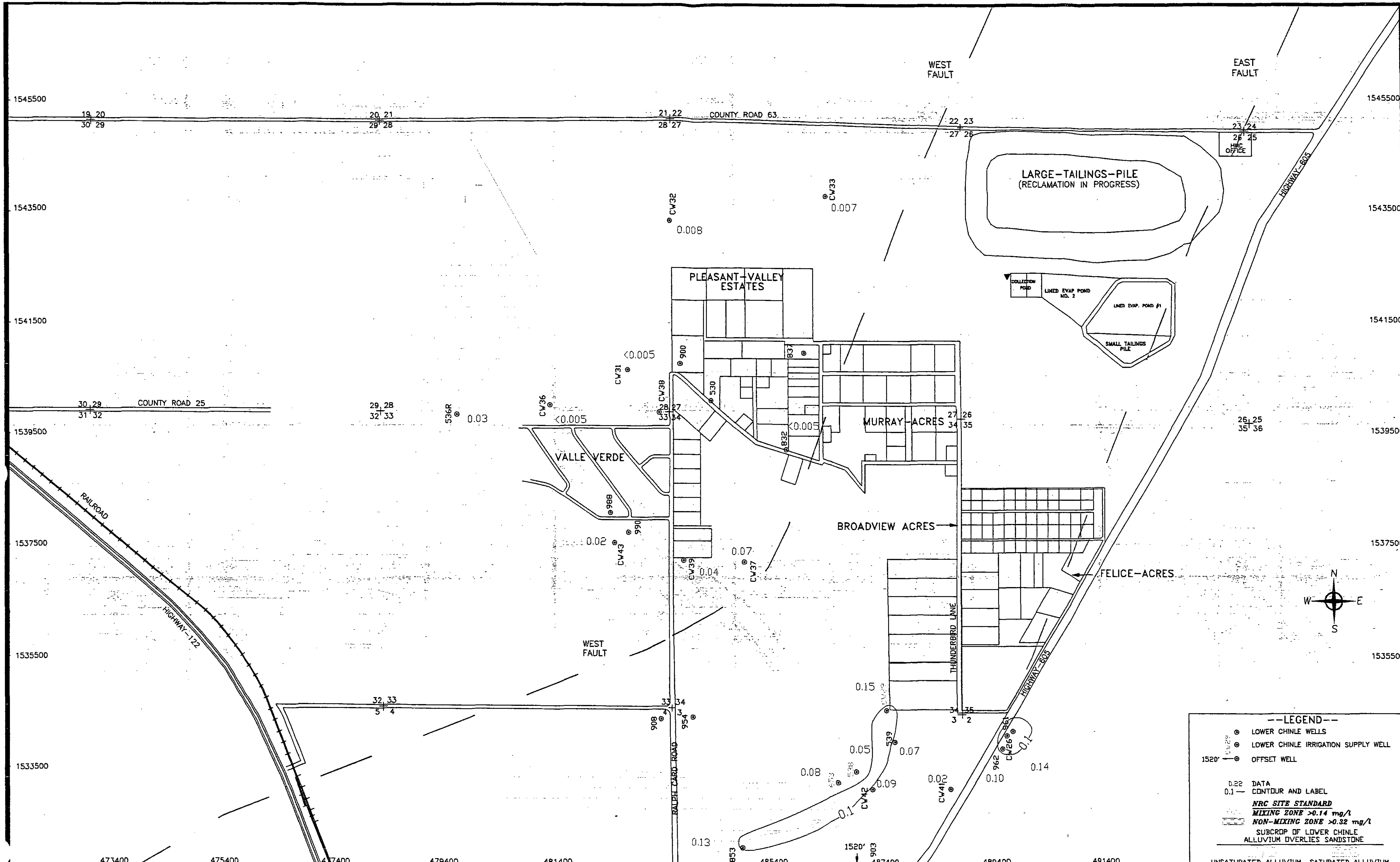
HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 7.3-5. TDS CONCENTRATIONS OF THE LOWER CHINLE AQUIFER, 2006, mg/l



SCALE: 1"=1600' C:\PROJECTS\2007-06\1600LOW DATE: 03/26/07	HOMESTAKE MILL AND ADJACENT PROPERTIES GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W	FIGURE 7.3-8. URANIUM CONCENTRATIONS OF THE LOWER CHINLE AQUIFER, 2006, mg/l



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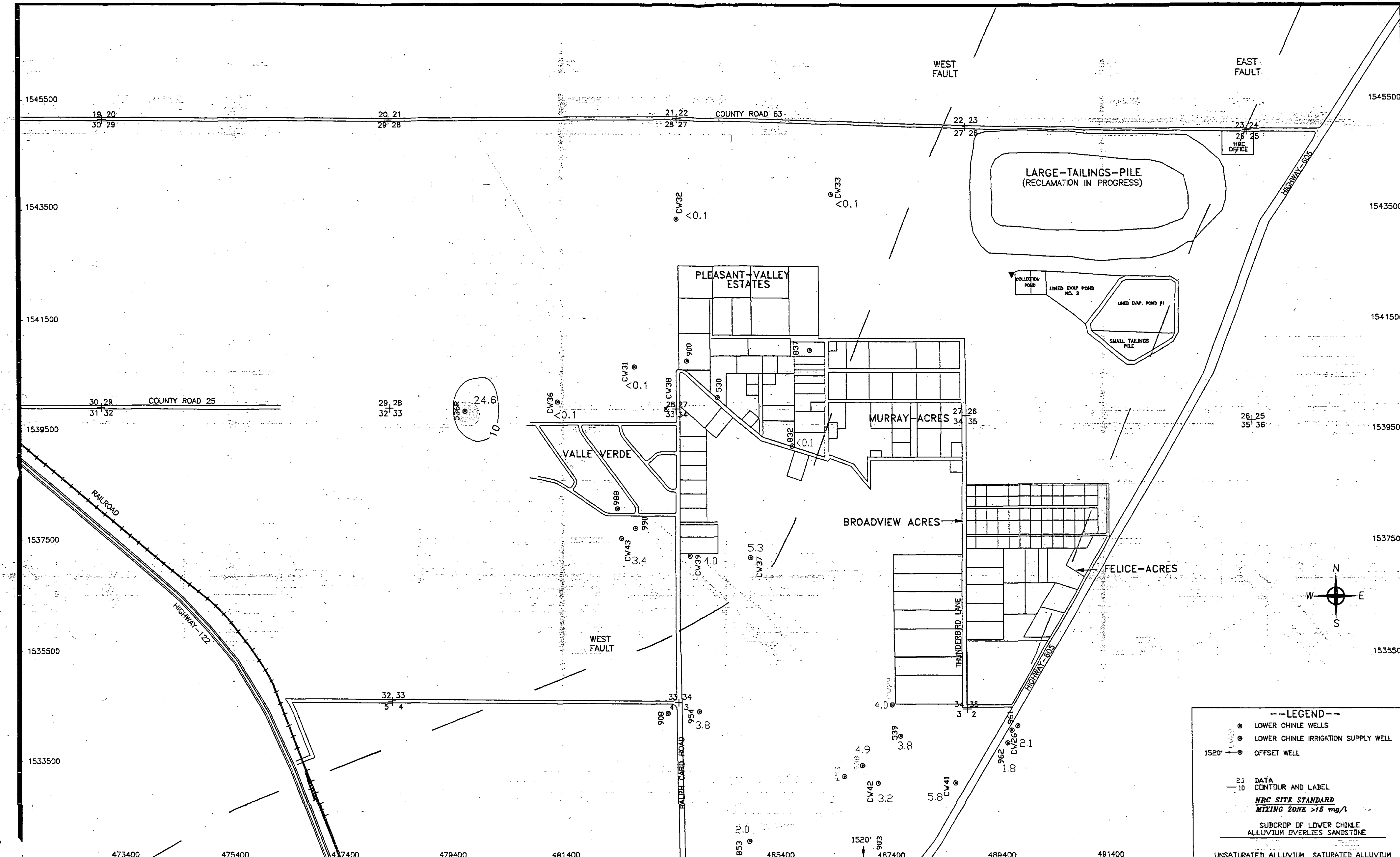
2007-06\1600LOW
DATE: 03/26/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 7.3-11. SELENIUM CONCENTRATIONS OF THE LOWER CHINLE AQUIFER, 2006, mg/l



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DATE: 03/26/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

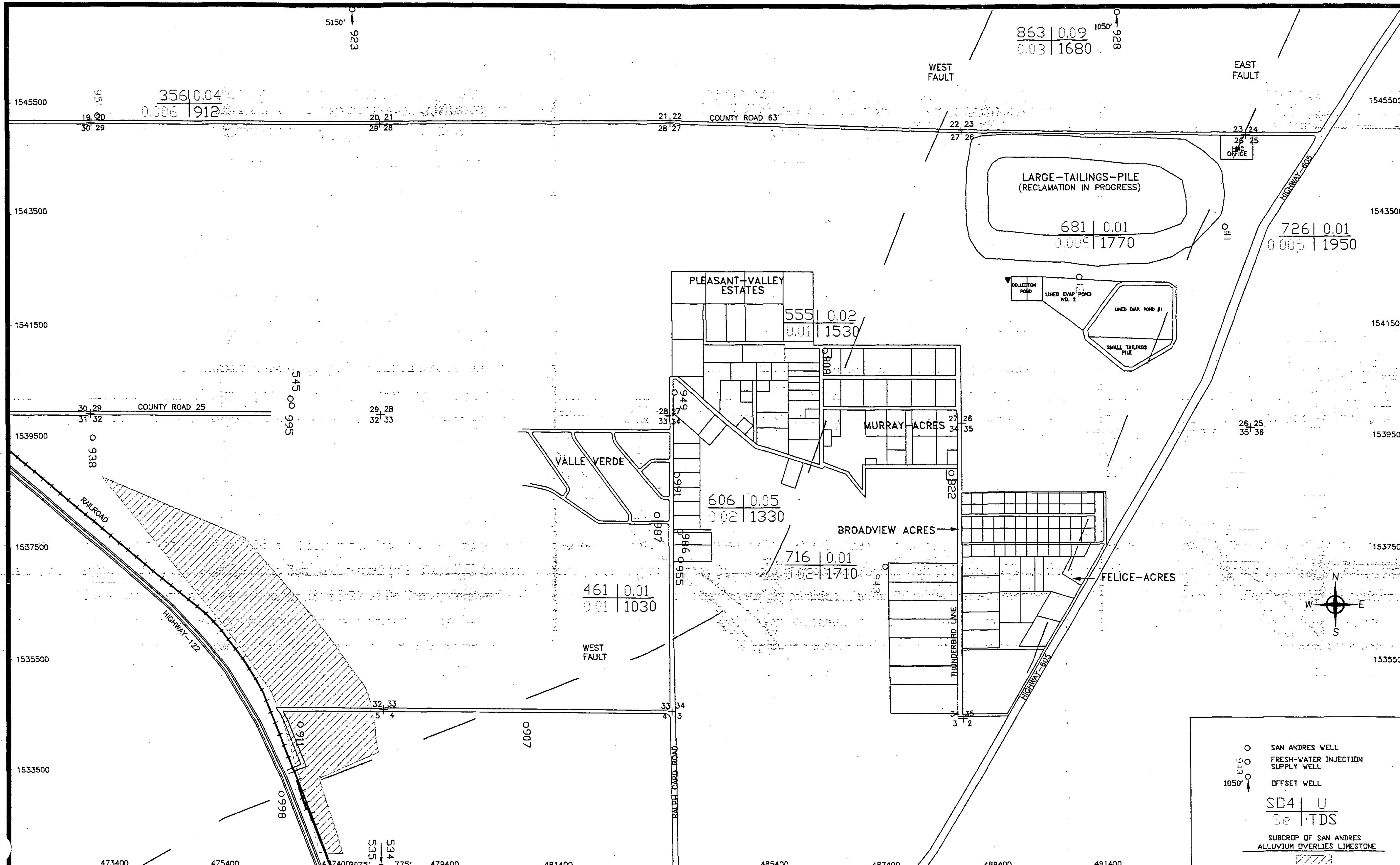
GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 7.3-14. NITRATE CONCENTRATIONS OF THE LOWER CHINLE AQUIFER, 2006, mg/l

8.0 SAN ANDRES AQUIFER MONITORING

The San Andres aquifer is the most important regional aquifer in the Grants Project area. The Chinle Formation, which exists between the alluvium and the San Andres, is approximately 800 feet thick at the Homestake tailings site and is primarily a shale with a few sandstone lenses. Therefore, the alluvial aquifer and the San Andres aquifer are separated by a very thick aquitard. The difference in piezometric head between the alluvial and San Andres aquifers is in the range of 80 to 100 feet, which confirms that the flow between the two systems is restricted by the limited permeability of the Chinle Formation. The San Andres and alluvial aquifers are only in direct contact in the western portion of the area presented on Figure 8.0-1 (see magenta pattern area). With no areas of direct communication within the area where the alluvial aquifer is impacted by tailings seepage, and only very limited hydraulic communication through the Chinle shale, the San Andres aquifer is not affected by tailings seepage. The San Andres aquifer has been used as the source for fresh-water injection into the alluvium and Chinle aquifers at the Grants Project, and as a result, a monitoring program was established for the San Andres aquifer.

Table 8.0-1 presents well completion information for the San Andres wells in this area. Homestake's two deep wells within the project area are San Andres wells, #1 Deep and #2 Deep. These wells are used to supply the fresh-water injection systems within the collection area. San Andres well 951 is used as the fresh-water injection supply for the injection system in Sections 28 and 29 while San Andres well 943 is used as the fresh water injection supply for the injection system in Sections 3 and 34 and Felice Acres. Figure 8.0-1 shows the locations of the San Andres wells relevant to this area. Recharge to the San Andres aquifer occurs mainly west of the area shown in the figure and in the far western portion of the figure. The structure of the San Andres aquifer dips to the east, and thus the ground water system becomes progressively deeper in the easterly direction. The water-level elevations measured during 2006 (Figure 8.0-1) show a very flat piezometric surface with the gradient being from the west-northwest to the east-southeast. The continuity of the gradient in this area indicates that the East and West faults do not significantly affect the ground water flow in the San Andres aquifer. The displacement at the faults is not large enough to completely displace the entire thickness of this aquifer system. The increase in gradient in the project area also indicates a decrease in transmissivity in the area of



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DATE: 03/27/07

HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 8.0-2. WATER QUALITY FOR THE SAN ANDRES AQUIFER, 2006, mg/l

REFERENCES

13-16

Homestake Mining Company - Grants Project

Parameter Codes

Parameter Code	Parameter Name	Parameter Units	Parameter Description
1	Ca	(mg/l)	Calcium, Dissolved
2	Mg	(mg/l)	Magnesium, Dissolved
3	K	(mg/l)	Potassium, Dissolved
4	Na	(mg/l)	Sodium, Dissolved
5	HCO3	(mg/l)	Bicarbonate, Dissolved
6	CO3	(mg/l)	Carbonate, Dissolved
7	Cl	(mg/l)	Chlorine, Dissolved
8	SO4	(mg/l)	Sulfate, Dissolved
9	pH	(std. units)	pH
10	TDS	(mg/l)	Total Dissolved Solids
11	Cond	(micromhos/cm)	Conductivity "Micromohs Meter"
12	Temp	(deg. C)	Temperature Celsius
13	WL	(feet)	Water Level Below Measuring Point
14	CE	(ft-msl)	Casing Elevation (Feet)
15	Unat	(mg/l)	U-Nat, Dissolved
16	KNO3	(mg/l)	Nitrogen Kjedahl, Dissolved
17	BV	(gallons)	Bail Volume
18	TD	(feet)	Total Depth Below Measuring Point
19	DDT PSI	(psi)	Drawdown Tube Pressure
20	Vacuum	(in-Hg)	Well Head Vacuum
21	Pump PSI	(psi)	Pump Pressure
22	Al	(mg/l)	Aluminum, Dissolved
23	As	(mg/l)	Arsenic, Dissolved
24	Ba	(mg/l)	Barium, Dissolved
25	B	(mg/l)	Boron, Dissolved
26	Cd	(mg/l)	Cadmium, Dissolved
27	Cr	(mg/l)	Chromium, Dissolved
28	Co	(mg/l)	Cobalt, Dissolved
29	Cu	(mg/l)	Copper, Dissolved
30	Cn	(mg/l)	Cyanide, Dissolved
31	F	(mg/l)	Flouride, Dissolved
32	Fe	(mg/l)	Iron, Dissolved
33	Pb	(mg/l)	Lead, Dissolved
34	Mn	(mg/l)	Manganese, Dissolved
35	Hg	(mg/l)	Mercury, Dissolved
36	Mo	(mg/l)	Molybdenum, Dissolved
37	Ni	(mg/l)	Nickel, Dissolved
38	NH3	(mg/l)	Ammonia, Dissolved
39	NO3	(mg/l)	Nitrate, Dissolved
40	Se	(mg/l)	Selenium, Dissolved
41	Ag	(mg/l)	Silver, Dissolved
42	V	(mg/l)	Vanadium, Dissolved
43	Zn	(mg/l)	Zinc, Dissolved
44	U3O8	(mg/l)	Uranium Oxide, Dissolved
45	Ra226	(pCi/l)	Radium 226, Dissolved

#1 Deepwell - CW21

Sample Point	Sample Date	Parameter Code	Remark Code	Value Symbol	Sample Value
0951	08/31/95	15 N			0.019
0951	03/07/96	15 N			0.017
0951	10/22/96	15 N			0.0052
0951	08/21/97	15 N			0.024
0951	12/17/97	15 N			0.0238
0951	08/18/98	15 N			0.025
0951	08/19/99	15 N			0.025
0951	09/17/99	15 N			0.0256
0951	10/19/99	15 N			0.0248
0951	11/02/99	15 N			0.023
0951	12/10/99	15 N			0.0204
0951	01/20/00	15 N			0.0316
0951	08/09/00	15 N			0.003
0951	10/17/02	15 N			0.028
0951	10/27/03	15 N			0.0314
0951	12/08/04	15 N			0.0272
0951	04/25/05	15 N			0.0281
0951	12/05/05	15 N			0.033
0951	03/16/06	15 N			0.0372

NEW MEXICO
ENVIRONMENT DEPARTMENT

Ground Water Quality Bureau

Harold Runnels Building
1190 St. Francis Drive, P. O. Box 26110
Santa Fe, NM 87502-6110
Phone (505)827-2918 Fax (505) 827-2965
www.nmenv.state.nm.us

BILL RICHARDSON
Governor
DIANE DENISH
Lieutenant Governor

RON CURRY
Secretary
CINDY PADILLA
Deputy Secretary

October 17, 2007

Mr. Chris Clayton
Office of Long-Term Stewardship, Office of Environmental Management, U.S. Department of Energy
Forestal Building
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Mr. Ron Linton
Senior Groundwater Hydrologist/Project Manager
U.S. Nuclear Regulatory Commission Office of Federal and State Materials and Environmental Management Programs
Mail Stop T-8F5
11545 Rockville Pike
Rockville, MD 20852-2738

RE: Request for NRC and DOE San Andres Aquifer Sampling Due to Concerns Relating to the Anaconda Bluewater Mill and Homestake Uranium Mill sites, New Mexico

Dear Mr. Clayton and Mr. Linton:

Through its oversight of ongoing ground water remedial activities at the Homestake Uranium Mill Superfund Site, the New Mexico Environment Department (NMED) has noted several San Andres completion wells that exhibit elevated or increasing concentrations of contaminants that are common to both the Homestake site that is under Nuclear Regulatory Commission (NRC) jurisdiction for reclamation, as well as the nearby Anaconda Bluewater Mill site that is under Department of Energy jurisdiction for long-term surveillance. The San Andres aquifer is the source for the nearby Village of Milan and City of Grants municipal water supply systems. Moreover, many residents of subdivisions south of the Homestake Site and southeast of the Bluewater Site have private wells, the majority of which are completed within aquifers overlying the San Andres. Since 2005, NMED has conducted a residential well sampling program within this area, which has revealed that many wells that are completed into these shallower aquifers have contaminant levels that exceed both Federal and State drinking water standards. NMED wants to ensure that the San Andres aquifer will remain available for safe human consumption to these, as well as to future, residents in this area.

Figures 1-6 are time-series plots of dissolved uranium concentrations in several San Andres-completion wells within the vicinity of these sites; Figure 7 shows the locations of these wells. One well (806) is known to have a bad completion, and is providing a pathway for cross-contamination from overlying contaminated aquifers; however the source of contamination in the other noted wells is currently unknown. As noted from these plots, uranium concentrations either are consistently above the State standard of 0.03 ppb (20.6.2.3103A NMAC) or show an increasing trend of dissolved uranium concentrations.

NMED is requesting that characterization studies of the San Andres aquifer within this area be performed to determine whether contaminants originating from the Homestake or Bluewater mill sites may be impacting this important aquifer. Please contact David L. Mayerson of my staff at (505) 476-3777 or david.mayerson@state.nm.us to discuss planning for this activity at your earliest convenience.

Sincerely,

Dana Bahar

Dana Bahar
Manager
Superfund Oversight Section

Copies:
- Mr. Sairam Appaji, EPA Region 6
- Mr. Milton Head, Bluewater Valley Downstream Alliance
- Mr. David L. Mayerson, NMED/SOS
- Mr. Jerry Schoeppner, NMED/MECS
- October 2007 NMED/SOS read file

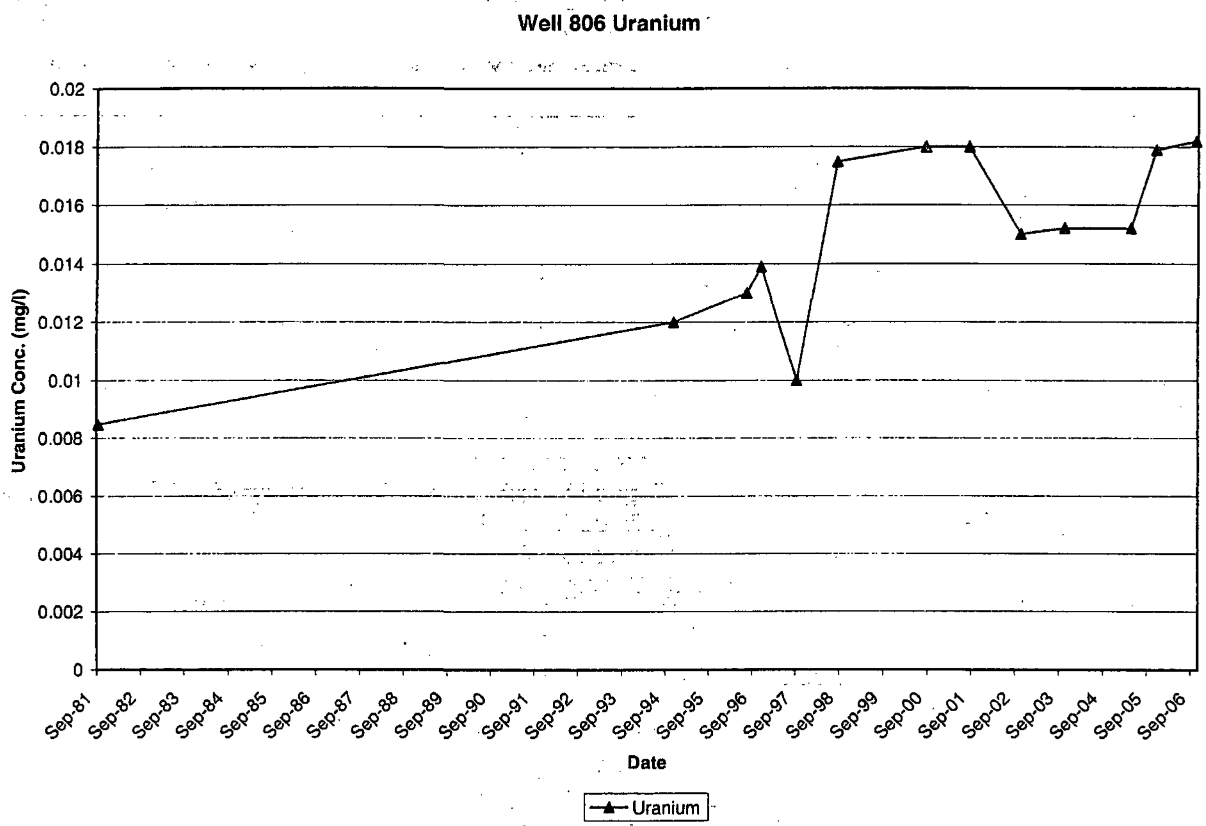
Well 806 Uranium
Uranium Conc. (mg/l)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Sep-81
Sep-82
Sep-83
Sep-84
Sep-85
Sep-86
Sep-87
Sep-88
Sep-89
Sep-90
Sep-91
Sep-92
Sep-93
Sep-94
Sep-95
Sep-96
Sep-97
Sep-98
Sep-99
Sep-00
Sep-01
Sep-02
Sep-03
Sep-04
Sep-05
Sep-06
Date
Uranium

Figure 1

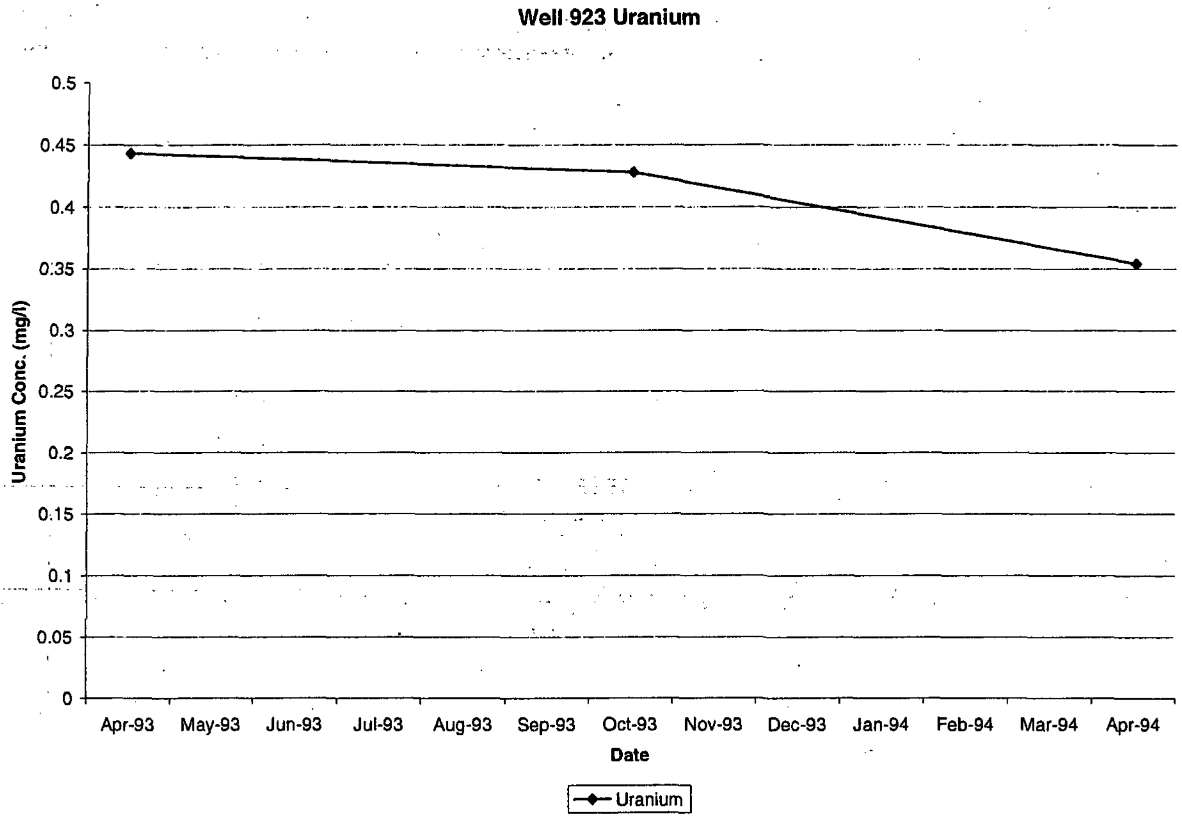
Well 923 Uranium
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Uranium Conc. (mg/l)
Apr-93
May-93
Jun-93
Jul-93
Aug-93
Sep-93
Oct-93
Nov-93
Dec-93
Jan-94
Feb-94
Mar-94
Apr-94
Date
Uranium

Figure 2

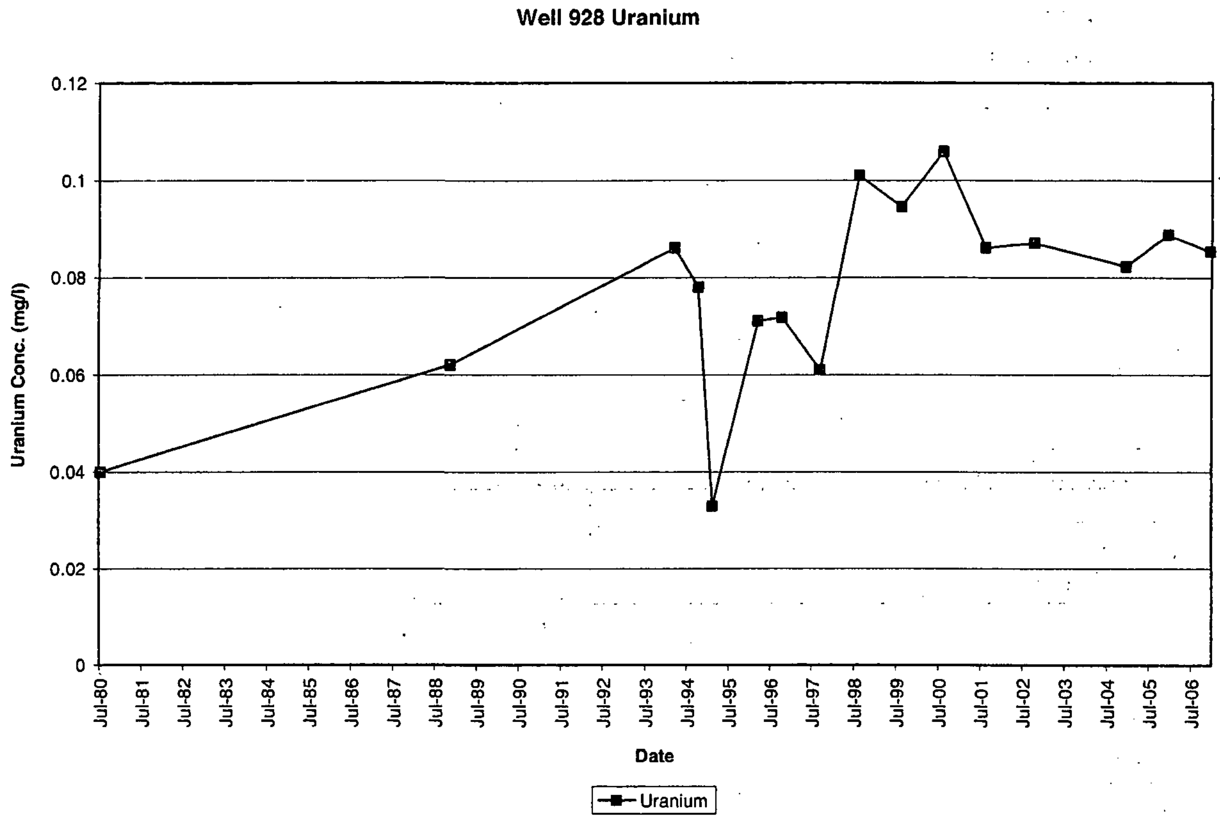
Well 928 Uranium
Uranium Conc. (mg/l)
0.12
0.1
0.08
0.06
0.04
0.02
0
Jul-80
Jul-81
Jul-82
Jul-83
Jul-84
Jul-85
Jul-86
Jul-87
Jul-88
Jul-89
Jul-90
Jul-91
Jul-92
Jul-93
Jul-94
Jul-95
Jul-96
Jul-97
Jul-98
Jul-99
Jul-00
Jul-01
Jul-02
Jul-03
Jul-04
Jul-05
Jul-06
Date
Uranium

Figure 3

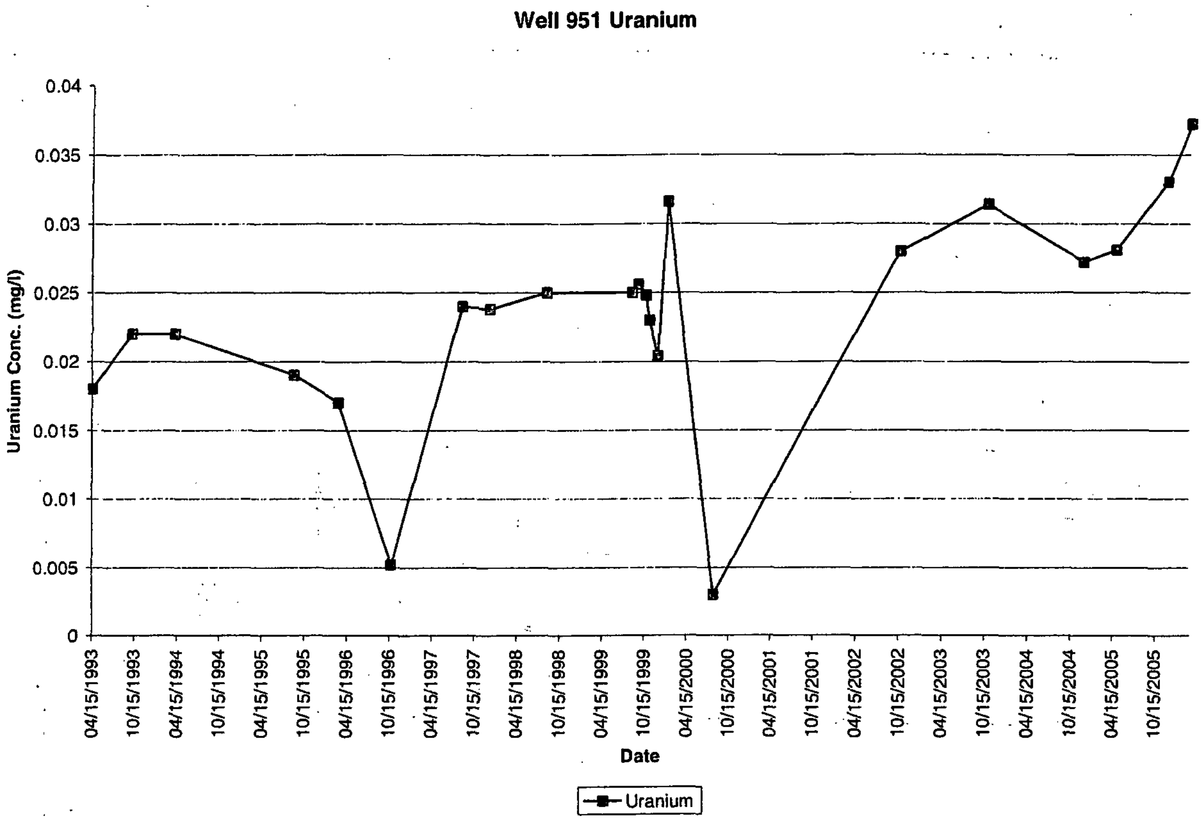
Well 951 Uranium
Uranium Conc. (mg/l)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
04/15/1993
10/15/1993
04/15/1994
10/15/1994
04/15/1995
10/15/1995
04/15/1996
10/15/1996
04/15/1997
10/15/1997
04/15/1998
10/15/1998
04/15/1999
10/15/1999
04/15/2000
10/15/2000
04/15/2001
10/15/2001
04/15/2002
10/15/2002
04/15/2003
10/15/2003
04/15/2004
10/15/2004
04/15/2005
10/15/2005
Date
Uranium

Figure 4

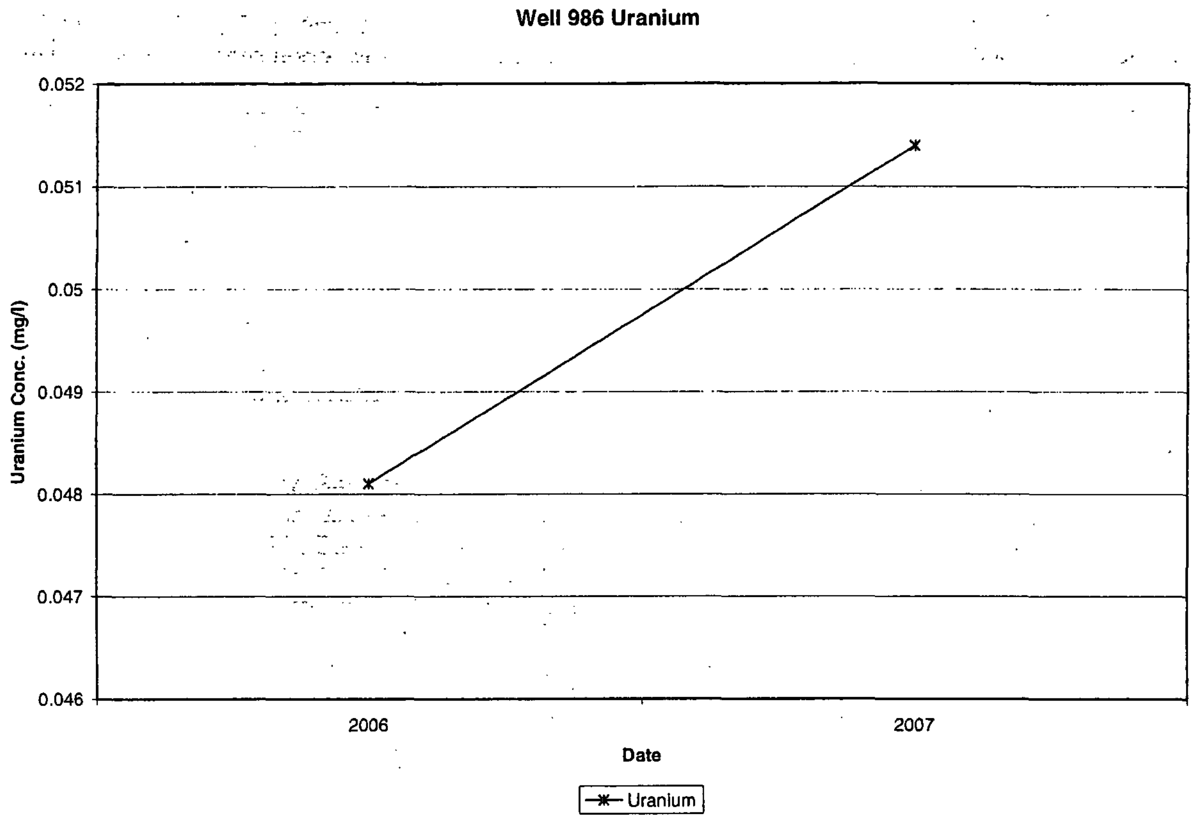
Well 986 Uranium
0.052
0.051
0.05
0.049
0.048
0.047
0.046
Uranium Conc. (mg/l)
2006
2007
Date
Uranium

Figure 5

Well 806	Sample date	Dissolved Uranium (ppb)
806	09/18/1981	0.00848
806	11/09/1994	0.012
806	07/24/1996	0.013
806	11/12/1996	0.0139
806	09/02/1997	0.01
806	08/10/1998	0.0175
806	08/22/2000	0.018
806	08/24/2001	0.018
806	10/17/2002	0.015
806	10/27/2003	0.0152
806	04/21/2005	0.0152
806	11/18/2005	0.0179
806	10/04/2006	0.0182
Well 923		
0923	04/07/93	0.443
0923	10/11/93	0.428
0923	04/06/94	0.354
Well 928		
0928	07/09/80	0.04
0928	11/15/88	0.062
0928	03/14/94	0.086
0928	10/24/94	0.078
0928	02/09/95	0.033
0928	03/08/96	0.071
0928	10/23/96	0.0717
0928	09/02/97	0.061
0928	08/27/98	0.101
0928	08/26/99	0.0945
0928	08/09/00	0.106
0928	08/29/01	0.086
0928	10/21/02	0.087
0928	12/09/04	0.0822
0928	12/05/05	0.0887
0928	12/10/06	0.0853
Well 951		
0951	04/15/93	0.018
0951	10/05/93	0.022
0951	04/05/94	0.022
0951	08/31/95	0.019
0951	03/07/96	0.017
0951	10/22/96	0.0052
0951	08/21/97	0.024

Well 806	Sample date	Dissolved Uranium (ppb)
0951	12/17/97	0.0238
0951	08/18/98	0.025
0951	08/19/99	0.025
0951	09/17/99	0.0256
0951	10/19/99	0.0248
0951	11/02/99	0.023
0951	12/10/99	0.0204
0951	01/20/00	0.0316
0951	08/09/00	0.003
0951	10/17/02	0.028
0951	10/27/03	0.0314
0951	12/08/04	0.0272
0951	04/25/05	0.0281
0951	12/05/05	0.033
0951	03/16/06	0.0372
Well 986		
986	05/02/06	0.0481
986	05/15/07	0.0514

Figure 6: Data from HMC

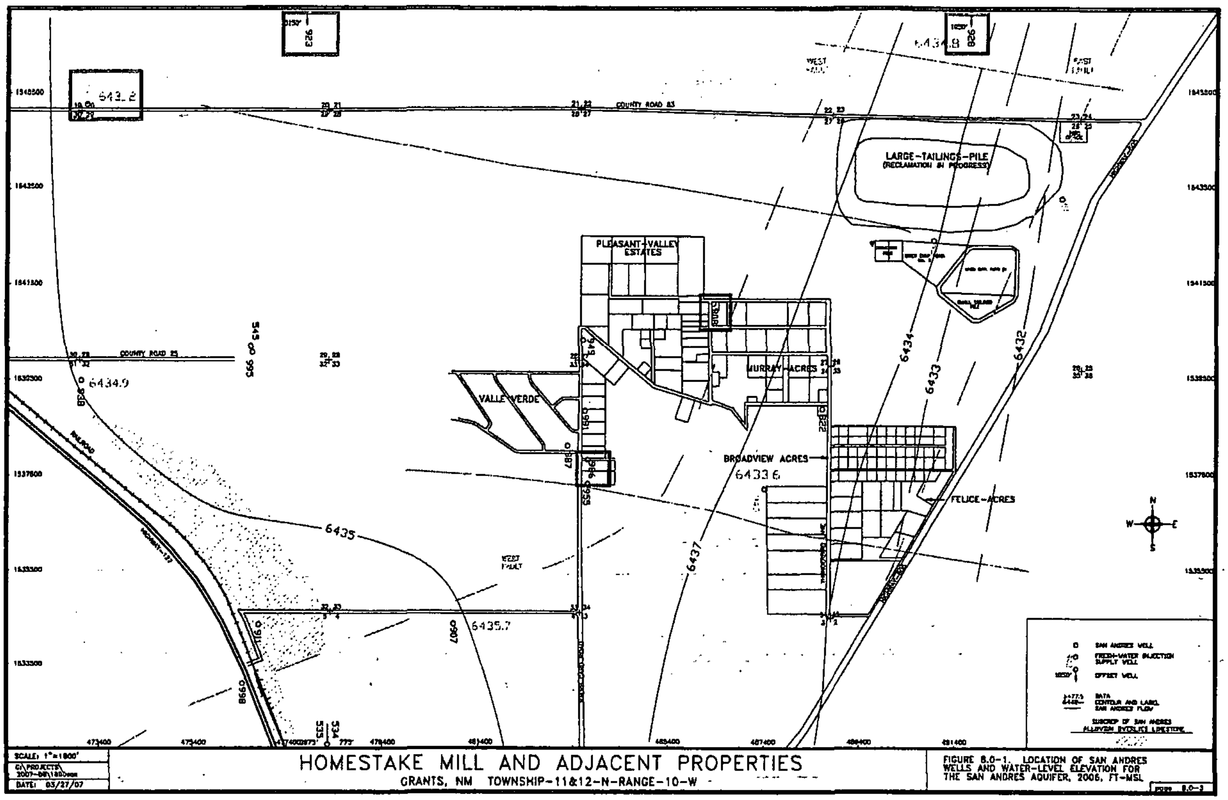

Figure 7: Well locations in preceding figures are highlighted by boxes

DEC 1 4 2001

GROUND WATER BUREAU

GROUND-WATER HYDROLOGY FOR SUPPORT OF BACKGROUND CONCENTRATION AT THE GRANTS RECLAMATION SITE

FOR:

HOMESTAKE MINING COMPANY
OF CALIFORNIA

BY:

HYDRO-ENGINEERING, L.L.C.
CASPER, WYOMING

DECEMBER, 2001

George L. Hoffman

GEORGE L. HOFFMAN, P.E.
HYDROLOGIST

2.0 GEOLOGIC SETTING AND AQUIFER CONNECTIONS

Tailings at the Grants site are located on top of the alluvium and therefore the alluvial aquifer is the most important ground-water system relative to the Grants site. The surface geology and structure contours are presented on United States Geological Survey (USGS) quadrangle topographic maps. Geologic maps and other geologic information were compiled and presented by New Mexico Bureau of Mines and Mineral Resources (NMBM) and USGS reports on the area. These reports have been used in defining the geologic setting at this site but are not necessary for the background review.

The uranium ore bearing rocks that have been mined in this area outcrop in the San Mateo drainage system and contain significant natural concentrations of uranium and selenium. Therefore, the alluvial material would be expected to contain above normal concentrations of uranium and selenium that are typically present in uranium deposits. The Chinle Formation forms the base of the alluvial aquifer at the Grants site. The Chinle Formation also contains some natural uranium and selenium concentrations. Therefore, the geologic setting has significantly affected the background water quality at this site.

The hydrologic conditions in this area have been defined by New Mexico State Engineer (NMSE), USGS and NMBM reports on the area. Ground-water conditions for the Grants site have been defined in previous documents submitted to the NRC and typically referenced in the annual reports on the site. These hydrologic reports have been used in developing the hydrologic conditions presented in this report at the Grants site and are not necessary for the background review and therefore not included in this submittal. The Grants project site exists on the San Mateo alluvial system. The San Mateo alluvial system follows the San Mateo alluvium and drainage system and extends from northeast of the site to the south and west. Bedrock material exists on the surface to the northeast and southeast sides of the alluvial material. Figure 2-1 shows a typical cross section at the Grants site with saturated alluvium shown in red.

The Chinle Formation, which is a massive shale (approximately 800 feet thick) at the tailings site, exists below the alluvium. The Chinle shale is a very good aquitard and greatly restricts movement vertically from the alluvial aquifer. A few sandstones exist within the Chinle shale, which form bedrock aquifers in this area. The cross section shows the Upper Chinle sandstone in blue and shows where the Upper Chinle sandstone subcrops against the alluvial aquifer forming a direct connection between these two ground-water systems. The second major sandstone in the Chinle Formation has been named the Middle Chinle sandstone. This sandstone is shown in magenta in the cross section and also subcrops against the alluvium further south. In this cross section a third permeable zone within the Chinle shale has been defined and is called the Lower Chinle aquifer. This zone consists mainly of fractured shale and is therefore highly variable depending on secondary permeability developed in the shale. The Lower Chinle aquifer is not used very much in this area due to its depth and naturally poor water quality. A few wells are completed in the Lower Chinle aquifer due to the lack of existence of the alluvial, Upper or Middle Chinle aquifers in some areas. The San Andres aquifer exists below the Chinle Formation as is the regional aquifer in this area. The San Andres is not discussed in this report because it has not been impacted by Homestake tailings seepage.

2.1 ALLUVIAL AQUIFER

This subsection presents the geologic setting and well completions for the alluvial aquifer. The basic well data for the background alluvial wells at the Grants site are presented in Tables 2-1 and Tables 2-2. The annual reports present the basic well data for all other wells at the site. Annual reports are not presented in this submittal because they were previously submitted to the NRC and are not required for this analysis. Figures 2-2A and 2-2B show the location of the alluvial wells that have been used to define the ground-water conditions in the alluvial aquifer at the Grants site. Figure 2-2B shows the locations of the nine alluvial background wells, which are listed in Table 2-1 north of the Large Tailings. Figure 5-1 also presents the locations of the nine background wells and locations

URANIUM RESOURCES IN NEW MEXICO

Virginia T. McLemore, NM Bureau of Geology and Min. Res., NM Inst. of Mining and Tech., Socorro, NM 87801

ABSTRACT

New Mexico ranks 2nd in uranium reserves in the U. S., which amounts to 15 million tons ore at 0.277% U_3O_8 (84 million lbs U_3O_8) at $30/lb (EIA, 2006). The most important deposit in the state is sandstone within the Morrison Formation (Jurassic) in the Grants district. More than 340 million pounds of U_3O_8 have been produced from these deposits from 1948-2002, accounting for 97% of the total production in New Mexico and more than 30% of the total production in the United States. Sandstone uranium deposits are defined as epigenetic concentrations of uranium in fluvial, lacustrine, and deltaic sandstones. Three types of sandstone uranium deposits are recognized: tabular (primary, trend, blanket, black-band), roll-front (redistributed, post-fault, secondary), and fault-related (redistributed, stack, post-fault). Several companies are planning to mine these deposits by in-situ leaching.

INTRODUCTION

During a period of nearly three decades (1951-1980), the Grants uranium district in northwestern New Mexico (Fig. 1) yielded more uranium than any other district in the United States (Table 1). Although there are no producing operations in the Grants district today, numerous companies have acquired uranium properties and plan to explore and develop deposits in the district in the near future. The Grants uranium district is one large area in the San Juan Basin, extending from east of Laguna to west of Gallup and consists of eight subdistricts (Fig. 1; McLemore and Chenoweth, 1989). The Grants district is probably 4th in total world production behind East Germany, Athabasca Basin in Canada, and South Africa (Tom Pool, General Atomics, Denver, Colorado, written communication, December 3, 2002). Most of the uranium production in New Mexico has come from the Morrison Formation in the Grants uranium district in McKinley and Cibola (formerly Valencia) Counties, mainly from the Westwater Canyon Member in the San Juan Basin (Table 2; McLemore, 1983).

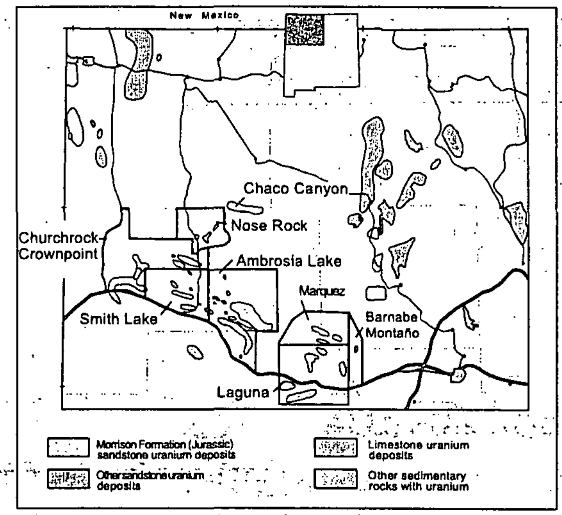

Figure 1. Grants uranium district, San Juan Basin, New Mexico. Polygons outline approximate areas of known uranium deposits.

The purpose of this report is to briefly describe the general types of uranium deposits (Table 2, 3) and their production, geology, resources, and future potential in New Mexico. Much of this report is summarized from McLemore (1983), McLemore and Chenoweth (1989, 2003), McLemore et al. (2002), and other reports as cited. This report also presents an update of the uranium industry in New Mexico since 2003. Information on specific mines and deposits in New Mexico can be found in cited references, McLemore (1983), and McLemore et al. (2002).

Table 1. Uranium production by type of deposit from the San Juan Basin, New Mexico 1947-2002 (McLemore and Chenoweth, 1989, 2003; production from 1988-2002 estimated by the senior author). Type of deposit refers to Table 3. Total U.S. production from McLemore and Chenoweth (1989) and Energy Information Administration (2006). [1] approximate figures rounded to the nearest 1000 pounds. There hasn't been any uranium production from New Mexico since 2002.

Type of deposit	Production (pounds U_3O_8)	Period of production (years)	Production per total in New Mexico (%)
Primary, redistributed, remnant sandstone uranium deposits (Morrison Formation, Grants district)	330,453,000[1]	1951-1988	95.4
Mine-water recovery	9,635,869	1963-2002	2.4
Tabular sandstone uranium deposits (Morrison Formation, Shiprock district)	493,510	1948-1982	0.1
Other Morrison sandstone uranium deposits	991	1955-1959	—
Other sandstone uranium deposits	503,279	1952-1970	0.1
Limestone uranium deposits (Todilto Formation)	6,671,798	1950-1985	1.9
Other sedimentary rocks with uranium deposits	34,889	1952-1970	—
Vein-type uranium deposits	226,162	1953-1966	—
Igneous and metamorphic rocks with uranium deposits	69	1954-1956	—
Total in New Mexico	348,019,000[1]	1948-2002	100
Total in United States	927,917,000[1]	1947-2002	37.5 of total U.S.

MINING AND MILLING HISTORY AND PRODUCTION

Interest in uranium as a commodity began in the early 1900s, and several deposits in New Mexico were discovered and mined for radium. Radium was produced from the White Signal district in Grant County (Gillerman, 1964) and the Scholle district in Torrance, Socorro, and Valencia Counties (McLemore, 1983). Exact production figures are unknown, but probably very small.

John Wade of Sweetwater, Arizona first discovered uranium and vanadium minerals in the Carrizo Mountains in the northwestern San Juan Basin about 1918 (Fig. 1; Chenoweth, 1993, 1997). At that time, the Navajo Reservation was closed to prospecting and mining, but on June 30, 1919, a Congressional Act opened the reservation to prospecting and locating mining claims in the same manner as prescribed by the Federal mining law. The locator of the claim could then lease the claim under contract with the Office of Indian Affairs. By 1920, Wade, operating as the Carriso Uranium Co., had located 40 claims in the eastern Carrizo Mountains, near Milepost 16. The area remained inactive from 1927 to 1942, at which time the Vanadium Corp. of America (VCA) was the highest bidder on a 104 sq mi exploration lease for vanadium in the east Carrizo Mountains. The lease was known as the East Reservation Lease (no. I-149-IND-5705) and was subsequently reduced to 12 plots or claims. When production began, ore from the East Reservation Lease was shipped to Monticello, Utah, where VCA operated the mill for the Metals Reserve Co. Uranium in the vanadium ore was secretly recovered via a uranium circuit at the Monticello mill for the Manhattan Project in 1943-1945. The total amount of recovered uranium is estimated as 44,000 lbs U_3O_8, mostly from King Tutt Mesa (Chenoweth, 1985b).

The U. S. Atomic Energy Commission (AEC) was created in 1947, and soon after, the VCA began exploring their East Reservation Lease for uranium. This led to the first uranium ore shipments in March 1948. Mining ceased in the east Carrizo Mountains in 1967.

Table 2. Classification of uranium deposits in New Mexico (modified from McLemore and Chenoweth, 1989; McLemore, 2001). Deposit types in bold are found in the Grants uranium district.

I. Peneconcordant uranium deposits in sedimentary host rocks

- A. **Morrison Formation (Jurassic) sandstone uranium deposits**
  - **Primary, tabular sandstone uranium-humate deposits in the Morrison Formation**
  - **Redistributed sandstone uranium deposits in the Morrison Formation**
  - **Remnant sandstone uranium deposits in the Morrison Formation**
  - Tabular sandstone uranium-vanadium deposits in the Salt Wash and Recapture Members of the Morrison Formation
- B. **Other sandstone uranium deposits**
  - **Redistributed uranium deposits in the Dakota Sandstone (Cretaceous)**
  - **Roll-front sandstone uranium deposits in Cretaceous and Tertiary sandstones**
  - Sedimentary uranium deposits
  - Sedimentary-copper deposits
  - **Beach placer, thorium-rich sandstone uranium deposits**
- C. **Limestone uranium deposits**
  - **Limestone uranium deposits in the Todilto Formation (Jurassic)**
  - Other limestone deposits
- D. **Other sedimentary rocks with uranium deposits**
  - **Carbonaceous shale and lignite uranium deposits**
  - Surficial uranium deposits

II. Fracture-controlled uranium deposits

- E. **Vein-type uranium deposits**
  - Copper-silver (uranium) veins (formerly Jeter-type, low-temperature vein-type uranium deposits and La Bajada, low-temperature uranium-base metal vein-type uranium deposits)
  - **Collapse-breccia pipes (including clastic plugs)**
  - Volcanic epithermal veins
  - Laramide veins

III. Disseminated uranium deposits in igneous and metamorphic rocks

- F. Igneous and metamorphic rocks with disseminated uranium deposits
  - Pegmatites
  - Alkaline rocks
  - Granitic rocks
  - Carbonatites
  - Miscellaneous

Table 3. Uranium production and types of deposits by district or subdistrict in the San Juan Basin, New Mexico (McLemore and Chenoweth, 1989, production from 1988-2002 estimated by the senior author). Districts have reported occurrences of uranium or thorium (>0.005% U_3O_8 or > 100 ppm Th). Some district names have been changed from McLemore and Chenoweth (1989) to conform to McLemore (2001). District number refers to number on map and Table 3 in McLemore and Chenoweth (1989). See McLemore (1983), McLemore and Chenoweth (1989, table 3), and McLemore et al. (2002) for more details and locations of additional minor uranium occurrences. Types of deposits defined in Table 2.

DISTRICT	PRODUCTION (lbs U_3O_8)	GRADE (U_3O_8%)	PERIOD OF PRODUCTION	TYPES OF DEPOSITS
Grants district				
1. Laguna	>100,600,000	0.1-1.3	1951-1983	A, C, E
2. Marquez	28,000	0.1-0.2	1979-1980	A
3. Bernabe Montaño	None			A
4. Ambrosia Lake	>211,200,000	0.1-0.5	1950-2002	A, B, C, E
5. Smith Lake	>13,000,000	0.2	1951-1985	A, C
6. Church Rock-Crownpoint	>16,400,000	0.1-0.2	1952-1986	A, B
7. Nose Rock	None			A
8. Chaco Canyon	None			A
Shiprock district				
9. Carrizo Mountains	159,850	0.23	1948-1967	A
10. Chuska	333,685	0.12	1952-1982	A, C, B
11. Tocito Dome	None			A
12. Toadlena	None			B
Other areas and districts				
13. Zuni Mountains	None			B, E, F
14. Boyd prospect	74	0.05	1955	B
15. Farmington	3	0.02	1954	B
18. Chama Canyon	None			B
19. Gallina	19	0.04	1954-1956	B
20. Eastern San Juan Basin	None			B
21. Mesa Portales	None			B
22. Dennison Bunn	None			A
23. La Ventana	290	0.63	1954-1957	D
24. Collins-Warm Springs	989	0.12	1957-1959	A
25. Ojito Spring	None			A
26. Coyote	182	0.06	1954-1957	B, C
27. Nacimiento	None			B
28. Jemez Springs	None			B

From 1948 through 1966, the AEC purchased all of the uranium concentrate produced in New Mexico. During the last few years of the AEC program (1967-1970), the AEC allowed mill operators to sell uranium to electric utilities. In New Mexico this amounted to over 17 million pounds of U_3O_8 (USAEC unpublished records). The price schedules, bonuses, and other incentives offered by the AEC created a prospecting boom that spread across the Four Corners area to all parts of New Mexico. Discoveries were made in the Chuska Mountains near Sanostee and in the Todilto Limestone near Grants. The announcement of Paddy Martinez's discovery of uranium in the Todilto Limestone at Haystack Butte in 1950 brought uranium prospectors to the Grants area. It was Lewis Lothman's discovery in March 1955 at Ambrosia Lake that created the uranium boom in that area. These discoveries led to a significant exploration effort in the San Juan Basin between Laguna and Gallup and ultimately led to the development of the Grants uranium district. Production from the Todilto Limestone deposits began in 1950, with a shipment of ore to the AEC ore-buying station at Monticello, Utah. Mills were soon built and operated in the San Juan Basin of New Mexico.

The Anaconda Bluewater mill was built at Bluewater, west of Grants in 1953 to process ores from the Jackpile mine and closed in 1982. ARCO Coal Company (formerly Anaconda) completed encapsulation of the tailings in 1995 and the U. S. Department of Energy (DOE) monitors the site as part of the Legacy Management program (formerly the Long-Term Surveillance and Maintenance, LTSM program).

The Homestake mill, 5.5 mi north of Milan, actually consisted of two mills. The southern mill, built in 1957, was known as the Homestake-New Mexico Partners mill and was closed in 1962 (Chenoweth, 1989b; McLemore and Chenoweth, 2003). The Homestake-Sapin Partners, a partnership between Homestake and Sabre Pinon Corp., in 1957 built a second, larger mill north of the first facility. In 1962, United Nuclear Corp. merged with Sabre Pinon Corp., but maintained the United Nuclear Corp. name. United Nuclear Corp. became the limited partner with Homestake forming the United Nuclear-Homestake partnership and continued operating the mill. In March 1981, the United Nuclear-Homestake Partnership was dissolved and Homestake became the sole owner. The Homestake mill ceased production in 1981, but reopened in 1988 to process ore from the Section 23 mine and Chevron's Mount Taylor mine. The mill closed soon after and was decommissioned and demolished in 1990. In 2001, Homestake Corp. merged with Barrick Gold Corp. Homestake completed reclamation of the Homestake mill at Milan in 2004.

Kerr-McGee Oil Industries, Inc. built the Shiprock (Navajo) mill at Shiprock in 1954. It processed ore from their mines in the Lukachukai Mountains in Arizona and non-Vanadium Corporation of America (VCA) controlled mines on the Navajo Indian Reservation. It also processed ores from the Gallup and Poison Canyon areas in the Grants district. The mill was acquired by VCA in 1963 and closed in May 1968, one year after VCA merged into Foote Mineral Company. The DOE began cleanup of the site in 1968 as part of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. Cleanup was achieved in 1996 and the site turned over to the Legacy Management program of the DOE for monitoring.

Kermac Nuclear Fuels Corp., a partnership of Kerr-McGee Oil Industries, Inc., Anderson Development Corp., and Pacific Uranium Mines Co., built the Kerr-McGee mill at Ambrosia Lake in 1957-58. In 1983, Quivira Mining Co., a subsidiary of Kerr-McGee Corp. (later Rio Algom Mining LLC, currently BHP-Billiton) became the operator. The mill began operating in 1958 and from 1985-2002, the mill produced only from mine waters from the Ambrosia Lake underground mines. Quivira Mining Co. is no longer producing uranium and the Ambrosia Lake mill and mines will be reclaimed in 2007.

Phillips Petroleum Co. also built a mill at Ambrosia Lake in 1957-58. Ore was from the Ann Lee, Sandstone, and Cliffside mines. Production began in 1958. United Nuclear Corp. acquired the property in 1963, when the mill closed. The DOE remediated the site between 1987 and 1995 as part of the UMTRCA of 1978. DOE monitors the site as part of the Legacy Management program.

Additional mills were built in the Laguna and Church Rock areas and are currently being reclaimed (McLemore and Chenoweth, 2003, table 5).

Annual uranium production in New Mexico increased steadily from 1948 to 1956, from 1957 to 1960, from 1965 to 1968, and from 1973 to 1979. Peak production was attained in 1978, with a record yearly production of 9,371 tons of U_3O_8 that was shipped to mills and buying stations (McLemore, 1983; McLemore and Chenoweth, 1989, 2003).

All of the conventional underground and open-pit mines in New Mexico closed by 1989 for several reasons:

- The Three Mile Island incident resulted in finalizing a growing public perception in the U.S. that nuclear power was dangerous and costly, and, subsequently nuclear power plants became unpopular.
- There was an overproduction of uranium in the 1970s-early 1980s that led to large stockpiles of uranium. In addition, the dismantling of nuclear weapons by the U.S. and Russia also increased these stockpiles, reducing the need for mining uranium.
- At the same time, New Mexico uranium deposits in production were decreasing in grade by nearly half.
- The cost of mine and mill reclamation was increasing in cost and was not accounted for in original mine plans.
- Higher grade, more attractive uranium deposits were found elsewhere in the world.
- Large coal deposits were found throughout the U.S. that could meet the nation's energy needs.

Uranium was produced from 1966-2002 by mine-water recovery from underground mines by Quivira Mining Co., formerly Kerr McGee Corp. The decline in the price of uranium during 1989-2005 resulted in no uranium production (except mine water recovery), exploration, or development in the district. Many companies reclaimed and/or sold their properties. However, today with the recent increase in price and demand for uranium, numerous companies are acquiring new and old properties and exploring for uranium in the Grants district. The Grants district is once again an attractive area for uranium exploration, because:

- Major companies abandoned properties in the district after the last cycle leaving advanced uranium projects.
- Current property acquisition costs are inexpensive and include millions of dollars worth of exploration and development expenditures.
- Data and technical expertise on these properties are available.
- Recent advances in in-situ leaching technology allow for the Grants district sandstone uranium deposits to be economically attractive.

TYPES OF URANIUM DEPOSITS IN NEW MEXICO

The types of uranium deposits in New Mexico are summarized in Table 2, many of which are found in the Grants district. The most important type of deposit in terms of production (Table 3) and resources (Table 4, 5) is sandstone uranium deposits in the Morrison Formation (Jurassic).

Sandstone uranium deposits in the Morrison Formation (Jurassic)

Sandstone uranium deposits account for the majority of the uranium production from New Mexico (McLemore and Chenoweth, 1989; 2003). The most significant deposits are those in the Morrison Formation, specifically the Westwater Canyon Member, where more than 340,565,370 pounds of U_3O_8 were produced from the Morrison from 1948 to 2002 (Table 2). In contrast, production from other sandstone uranium deposits in New Mexico amounts to 503,279 pounds of U_3O_8 (Table 2, 1952-1970; McLemore and Chenoweth, 1989). There are three types of deposits in the Westwater Canyon Member of the Morrison Formation: primary (trend or tabular), redistributed (stack), and remnant-primary sandstone uranium deposits (Fig. 2, 3).

Primary sandstone-hosted uranium deposits, also known as prefault, trend, blanket, and black-band ores, are found as blanket-like, roughly parallel ore bodies along trends, mostly in sandstones of the Westwater Canyon Member. These deposits are characteristically less than 8 ft thick, average more than 0.20% U_3O_8, and have sharp ore-to-waste boundaries (Fig. 2). The largest deposits in the Grants uranium district contain more than 30 million lbs of U_3O_8.

Redistributed sandstone-hosted uranium deposits, also known as post-fault, stack, secondary, and roll-type ores, are younger than the primary sandstone-hosted uranium deposits. They are discordant, asymmetrical, irregularly shaped, characteristically more than 8 ft thick, have diffuse ore-to-waste contacts, and cut across sedimentary structures. The average deposit contains approximately 18.8 million lbs U_3O_8 with an average grade of 0.16%. Some redistributed uranium deposits are vertically stacked along faults (Fig. 2, 3).

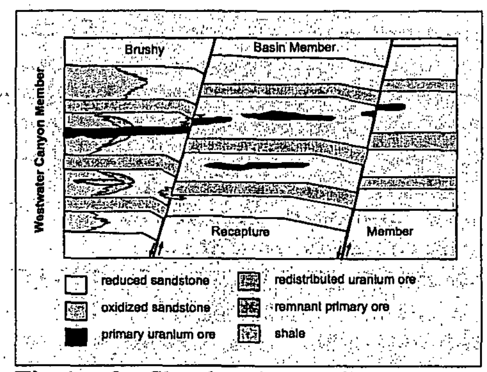

Figure 2. Sketch of the different types of uranium deposits in the Morrison Formation. See text for description.

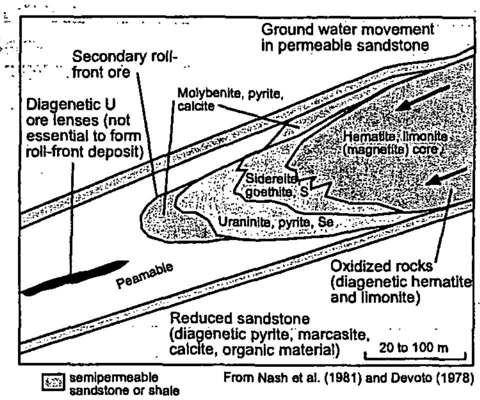

Figure 3. Sketch of the formation of redistributed sandstone uranium deposits. See text for description.

Table 4. Estimated uranium resources for New Mexico. All of these resources are in sandstone uranium deposits in the Morrison Formation (Jurassic). Mine id refers to Mine identification number in McLemore et al. (2002). Most deposits are delineated on maps by McLemore and Chenoweth (1991) and described in more detail by McLemore et al. (2002).

Mine id	Mine name	Latitude N	Longitude W	Year of resource estimate	Quantity of ore (pounds)	Grade (U_3O_8%)	Comments and Reference
NMCI0019	J. J.	35.17546	107.3266	1981	13,900,000	0.16	close out plan pending approval by state
NMCI0020	La Jara Mesa	35.28014	107.7449	1983	7,133,310	0.3	exploration permit approved
NMMK0245	Melrich (Section 32)	35.394462	107.7081		3,217,000	0.15	Laramide Resources
NMMK0210	Treeline (Section 24)	35.343556	107.7366		?	?	Western Energy Dev.
NMCI0027	Mount Taylor	35.33498	107.6356	1982	121,000,000	0.25	http://www.gat.com/riogrande/index.html (1/9/03)
NMMK0025	Canyon	35.65699	108.2069	1983	5,000,000	0.12	
NMMK0043	Dalton Pass	35.67849	108.2650	1983	5,000,000	0.12	
NMMK0044	Dalton Pass	35.68130	108.2783	1983	20,000,000	0.10	
NMMK0065	Fernandez-Main Ranch	35.34861	107.6646	1970	8,500,000	0.10	Holmquist (1970)
NMMK0087	Johnny M	35.36244	107.7222	1983	3,500,000	0.10	
NMMK0102	Mariano Lake	35.54708	108.2780	1983	35,000,000	0.24	
NMMK0103	Marquez Canyon	35.31919	107.3243	1983	10,700,000	0.112	
NMMK0104	Marquez Canyon	35.32425	107.3300	1983	6,800,000	0.10	
NMMK0111	Narrow Canyon	35.64484	108.2984	1983	6,900,000	0.12	
NMMK0112	NE Church Rock No. 1	35.66650	108.5027	1983	2,868,700	0.247	
NMMK0114	NE Church Rock No. 2	35.67663	108.5262	1979	15,000,000	0.19	Perkins (1979)
NMMK0115	NE Church Rock No. 3	35.69756	108.5487	1983	21,000,000	0.20	
NMMK0117	NE Church Rock	35.65841	108.5085	1969	15,000,000	0.15	Hazlett (1969)
NMMK0128	Church Rock (Section 8)	35.630313	108.55064	2002	6,529,000		Odell (2002), Pelizza and McCarn (2002, 2003a)
NMMK0034	Church Rock (Section 17)	35.622209	108.552728	2002	8,443,000		Odell (2002), Pelizza and McCarn (2002, 2003a)
NMMK0100, NMMK0101	Mancos	35.628936	108.580547	2002	4,164,000		Pelizza and McCarn (2002, 2003a)
NMMK0346, NMMK0036, NMMK0039	Crownpoint	35.684585	108.16769	2002	38,959,000	0.16	Odell (2002), Pelizza and McCarn (2002, 2003a)
NMMK0040	Crownpoint (Unit 1)	35.706678	108.22052	2002	27,000,000		Pelizza and McCarn (2002, 2003a)
NMMK0119	Nose Rock	35.88436	107.9916	1983	9,700,000	0.167	
NMMK0120	Nose Rock No. 1	35.83556	108.0553	1983	25,000,000	0.10	
NMMK0122	Nose Rock	35.83036	108.0641	1983	36,200,000	0.10	
NMMK0020	Borrego Pass	35.620119	107.943617	1983	15,000,000	0.15	Tom Pool (WC, 12/3/02)
NMMK0245	Section 32 (Melrich)	35.394462	107.708055		5,000,000	0.25	Tom Pool (WC, 12/3/02)
NMMK0338	Vanadium	35.33339	107.8563	1983	25,000,000	0.10	
NMMK0340	West Largo	35.52570	107.9215	1983	15,000,000	0.15	
NMMK0350	Nose Rock	35.84497	108.0501	1983	12,400,000	0.167	
NMSA0023	Bernabe	35.22761	107.0109	1971	15,000,000	0.10	
NMSA0057	Marquez Grant	35.30514	107.2908	1981	751,000	0.09	
NMCI0046	Saint Anthony	35.159088	107.306139	1982	8,000,000	0.10	close out plan pending approval
NMCI0050	San Antonio Valley	35.256361	107.258444		3,500,000	0.10	Tom Pool (WC, 12/3/02)
NMMK0143	Roca Honda	35.363139	107.699611	Late 1980s	3,000,000	0.19	Tom Pool (WC, 12/3/02)

Remnant sandstone-hosted uranium deposits were preserved in sandstone after the oxidizing waters that formed redistributed uranium deposits had passed. Some remnant sandstone-hosted uranium deposits were preserved because they were surrounded by or found in less permeable sandstone and could not be oxidized by the oxidizing ground waters. These deposits are similar to primary sandstone-hosted uranium deposits, but are difficult to locate because they occur sporadically within the oxidized sandstone. The average size is approximately 2.7 million lbs U_3O_8 at a grade of 0.20%.

There is no consensus on details of the origin of the Morrison primary sandstone uranium deposits (Sanford, 1992). The source of the uranium and vanadium is not well constrained. It could be derived from alteration of volcanic detritus and shales within the Morrison Formation (Thamm et al., 1981; Adams and Saucier, 1981) or from ground water derived from a volcanic highland to the southwest. The majority of the proposed models for their formation suggest that deposition occurred at a ground water interface between two fluids of different chemical compositions and/or oxidation-reduction states. Deposition involving two fluids was proposed many years ago during the early stages of exploration and production of uranium (Fischer, 1947; Shawe, 1956).

Subsequent models, such as the lacustrine-humate and brine-interface models, have refined or incorporated portions of these early theories. In the lacustrine-humate model, ground water was expelled by compaction from lacustrine muds formed by a large playa lake into the underlying fluvial sandstones where humate or secondary organic material precipitated as a result of flocculation into tabular bodies. During or after precipitation of the humate bodies, uranium was precipitated from ground water (Turner-Peterson, 1985; Fishman and Turner-Peterson, 1986). This model proposes the humate bodies were formed prior to uranium deposition. In the brine-interface model, uranium and humate were deposited during diagenesis by reduction at the interface of meteoric fresh water and ground water brines (Granger and Santos, 1986). In another variation of the brine-interface model, ground water flow is driven by gravity, not compaction. Ground water flowed down dip and discharged in the vicinity of the uranium deposits. Uranium precipitated in the presence of humates at a gravitationally stable interface between relatively dilute, shallow meteoric water and saline brines that migrated up dip from deeper in the basin (Sanford, 1982, 1992). Modeling of the regional ground water flow in the Colorado Plateau during Late Jurassic and Early Cretaceous times supports the brine-interface model (Sanford, 1982). The ground-water flow was impeded by up-thrown blocks of Precambrian crust and forced upwards. These zones of upwelling are closely associated with uranium-vanadium deposits throughout the Colorado Plateau (Sanford, 1982).

In the Grants district, the bleaching of the Morrison sandstones and the geometry of tabular uranium-vanadium bodies floating in sandstone beds supports the reaction of two chemically different waters, most likely a dilute meteoric water and saline brine from deeper in the basin. The intimate association of uranium-vanadium minerals with organic material, further indicates that they were deposited at the same time. Cementation and replacement of feldspar and quartz grains with uranium-vanadium minerals are consistent with deposition during early diagenesis.

During the Tertiary, after formation of the primary sandstone uranium deposits, oxidizing ground waters migrated through the uranium deposits and remobilized some of the primary sandstone uranium deposits (Saucier, 1981). Uranium was reprecipitated ahead of the oxidizing waters forming redistributed sandstone uranium deposits. Where the sandstone host surrounding the primary deposits was impermeable and the oxidizing waters could not dissolve the deposit, remnant-primary sandstone uranium deposits remain (Fig. 2, 3).

Sandstone uranium deposits occur in other formations in New Mexico, but were insignificant compared to the Morrison deposits (McLemore and Chenoweth, 1989); some companies are once again exploring in these units. Uranium reserves and resources remain in the Grants uranium district that could be mined in the future by conventional underground techniques and by in-situ leaching technologies (Table 6; Holen and Hatchell, 1986, McLemore and Chenoweth, 1991, 2003).

Table 5. Uranium reserves by forward-cost category by state as of 2003 (Energy Information Administration, 2006). The DOE classifies uranium reserves into forward cost categories of $30 and $50 per pound. Forward costs are operating and capital costs (in current dollars) that are still to be incurred to produce uranium from estimated reserves. Modern regulatory costs yet to be incurred would have to be added.

STATE	$30 per pound			$50 per pound		
	ORE (million tons)	GRADE (% U_3O_8)	U_3O_8 (million pounds)	ORE (million tons)	GRADE (% U_3O_8)	U_3O_8 (million pounds)
New Mexico	15	0.28	84	102	0.167	341
Wyoming	41	0.129	106	238	0.076	363
Arizona, Colorado, Utah	8	0.281	45	45	0.138	123
Texas	4	0.077	6	18	0.063	23
Other	6	0.199	24	21	0.094	40
Total	74	0.178	265	424	0.105	890

Tabular sandstone uranium-vanadium deposits in the Salt Wash and Recapture Members

Tabular sandstone uranium-vanadium deposits in the Salt Wash and Recapture Members of the Morrison Formation are restricted to the east Carrizo (including the King Tutt Mesa area) and Chuska Mountains subdistricts of the Shiprock district, western San Juan Basin, where production totals 493,510 pounds of U_3O_8 (Table 2). The Salt Wash Member is the basal member of the Morrison Formation and is overlain by the Brushy Basin Member (Anderson and Lucas, 1992, 1995; McLemore and Chenoweth, 1997). It unconformably overlies the Bluff-Summerville Formation, using older stratigraphic nomenclature (Anderson and Lucas, 1992), or the Wanakah Formation as proposed by Condon and Peterson (1986). The Salt Wash Member consists of 190-220 ft of interbedded fluvial sandstones and floodplain mudstones, shales, and siltstones. The mudstone and siltstone comprise approximately 5-45% of the total thickness of the unit (Masters et al., 1955; Chenoweth, 1993).

The tabular uranium deposits are generally elongated parallel to paleostream channels and are associated with carbonized fossil plant material. A cluster of small ore bodies along a trend could contain as much as 4000 tons of ore averaging 0.23% U_3O_8 (Hilpert, 1969; Chenoweth and Learned, 1984; McLemore and Chenoweth, 1989, 1997). They tend to form subhorizontal clusters that are elongated and blanket-like. Ore bodies in the King Tutt Mesa area are small and irregular and only a few ore bodies have yielded more than 1000 lbs of U_3O_8. A typical ore body in the King Tutt Mesa area is 150-200 ft long, 50-75 ft wide, and approximately 5 ft thick (McLemore and Chenoweth, 1989, 1997). The deposits are typically concordant to bedding, although discordant lenses of uranium-vanadium minerals cross-cut bedding planes locally. The ore bodies typically float in the sandstone; locally, they occur at the interface between sandstone and less permeable shale or siltstone. However, unlike uranium deposits in the Grants district, the deposits at King Tutt Mesa are high in vanadium. The U:V ratio averages 1:10 and ranges 1:1 to 1:16.

The deposits are largely black to red, oxidized, and consist of tyuyamunite, meta-tyuyamunite, uranium/organic compounds, and a variety of vanadium minerals, including vanadium clay (Corey, 1958). Uranium and vanadium minerals are intimately associated with detrital organic material, such as leaves, branches, limbs, and trunks, derived from adjacent sandbar, swamp, and lake deposits, and humates. Small, high-grade ore pods (>0.5% U_3O_8) were associated with fossil wood. The uranium-vanadium minerals form the matrix of the mineralized sandstones and locally replace detrital quartz and feldspar grains. Mineralized beds are associated with coarser-grained sandstone, are above calcite-cemented sandstone or mudstone-siltstone beds, are associated locally with mudstone galls, and are near green to gray mudstone lenses. Limonite is commonly associated with the ore bodies (Masters et al., 1955). Field and petrographic data suggests that the uranium-vanadium deposits formed shortly after deposition of the host sediments (Hilpert, 1969).

Modeling of the regional ground-water flow in the Colorado Plateau during Late

Jurassic and Early Cretaceous times supports the brine-interface model and indicates that the regional ground-water flow was to the northeast in the King Tutt Mesa area (Sanford, 1982). In the King Tutt Mesa area, the bleaching of the sandstones and the geometry of tabular uranium-vanadium bodies floating in sandstone beds supports the reaction of two chemically different waters, most likely a dilute meteoric water and saline brine from deeper in the basin (McLemore and Chenoweth, 1997). The intimate association of uranium-vanadium minerals with organic material, further indicates that they were deposited at the same time.

Other sandstone uranium deposits

Redistributed uranium deposits in the Dakota Sandstone (Cretaceous)

A total of 501,169 pounds of U_3O_8 has been produced from redistributed uranium deposits in the Dakota Sandstone in the southern part of the San Juan Basin (Table 2; Chenoweth, 1989a). These deposits are similar to redistributed uranium deposits in the Morrison Formation and are found near primary and redistributed deposits in the Morrison Formation. Deposits in the Dakota Sandstone are typically tabular masses that range in size from thin pods a few feet long and wide to masses as much as 2500 ft long and 1000 ft wide. The larger deposits are only a few feet thick, but a few are as much as 25 ft thick (Hilpert, 1969). Ore grades ranged from 0.12 to 0.30% U_3O_8 and averaged 0.21% U_3O_8. Uranium is found with carbonaceous plant material near or at the base of channel sandstones or in carbonaceous shale and lignite and is associated with fractures, joints, or faults and with underlying permeable sandstone of the Brushy Basin or Westwater Canyon Members.

The largest deposits in the Dakota Sandstone are found in the Old Church Rock mine in the Church Rock subdistrict of the Grants district, where uranium is associated with a major northeast-trending fault. More than 188,000 lbs of U_3O_8 have been produced from the Dakota Sandstone in the Old Church Rock mine (Chenoweth, 1989a).

Roll-front sandstone uranium deposits

Roll-front sandstone uranium deposits are found in Tesuque Formation (San Jose) and Ojo Alamo Sandstone (Farmington, Mesa Portales) areas of the San Juan Basin, where production totals 60 pounds of U_3O_8 (Table 2; McLemore and Chenoweth, 1989). Roll-front uranium deposits typically are found in permeable fluvial channel sandstones and are associated with carbonaceous material, clay galls, sandstone-shale interfaces, and pyrite at an oxidation-reduction interface (Nash et al., 1981). Although only a few minor and unverified uranium occurrences have been reported at Mesa Portales (McLemore, 1983), radiometric anomalies are detected by water, stream-sediment, and aerial-radiometric studies (Green et al., 1980a, b). Past drilling at Mesa Portales indicated that low-grade uranium is found in blanket-like bodies in several horizons. The lack of a clear mineralization pattern suggests that these deposits are modified roll-type or remnant ore bodies (Green et al., 1980a, b).

Sedimentary sandstone uranium deposits

Sedimentary sandstone uranium deposits are stratabound deposits associated with syngenic organic material or iron oxides, or both, such as at the Boyd deposit near Farmington and in the Chinle Formation throughout northern New Mexico. Uranium contents vary, but average grades of shipments from these deposits rarely exceeded 0.1% U_3O_8. These deposits tend to be small, containing only a few tons of ore, and the potential for future production is low.

Sedimentary-copper deposits

Stratabound, sedimentary-copper deposits containing Cu, Ag, and locally Au, Pb, Zn, U, V, and Mo are found throughout New Mexico. These deposits also have been called "red-bed" or "sandstone" copper deposits by previous workers (Soulé, 1956; Phillips, 1960; Cox and Singer, 1986). They typically occur in bleached gray, pink, green, or tan sandstones, siltstones, shales, and limestones within or marginal to typical thick red-bed sequences of red, brown, purple, or yellow sedimentary rocks deposited in fluvial, deltaic or marginal-marine environments of Pennsylvanian, Permian, or Triassic age (Coyote, Gallina). The majority of sedimentary-copper deposits in New Mexico are found at or near the base of these sediments; some deposits such as those in the Zuni Mountains and Nacimiento districts (Fig. 4), are in sedimentary rocks that unconformably overlie mineralized Proterozoic granitic rocks. The mineralized bodies typically form as lenses or blankets of disseminated and/or fracture coatings of copper minerals, predominantly chalcopyrite, chalcocite, malachite, and azurite with minor to trace uranium minerals. Copper and uranium minerals in these sedimentary-copper deposits are

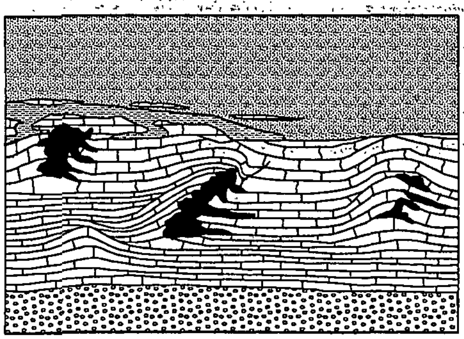

Figure 6. Control of Todilto uranium deposits by intraformational folds and fractures (modified from Finch and McLemore, 1989).

More than 100 uranium mines and occurrences are found in the Todilto Limestone in New Mexico; 42 mines have documented uranium production (McLemore, 1983; McLemore and Chenoweth, 1989; McLemore et al., 2002). Most of these are in the Grants uranium district, although minor occurrences are found in the Chama Basin (Abiquiu, Box Canyon), Nacimiento district, and Sanostee in the Chuska subdistrict of the Shiprock district. Minor mineralization extends into the underlying Entrada Sandstone or overlying Summerville Formation in some areas. Uranium is found in the Todilto Limestone only where gypsum-anhydrite beds are absent (Hilpert, 1969).

Other sedimentary rocks with uranium deposits

Carbonaceous shale and lignite uranium deposits

Some uranium has been produced from shale and lignite in the Dakota Sandstone in the Grants uranium district. Concentrations as high as 0.62% U_3O_8 are found in coal, whereas the coal ash has uranium concentrations as high as 1.34% U_3O_8 (Bachman et al., 1959; Vine et al., 1953). Mineralized zones are thin and range in thickness from a few inches to 1.5 ft. Most of these occurrences are isolated, small, and low grade, and do not have any significant uranium potential.

Vein-type uranium deposits

Collapse-breccia pipe and clastic plug deposits

Uraniferous collapse-breccia pipe deposits were mined in northern Arizona for uranium beginning in 1951 and continuing into the1980s; average production grades of 0.5-0.7% U_3O_8 were common. Similar deposits are found in the Grants uranium district. Uraniferous collapse-breccia pipes are vertical or steeply dipping cylindrical features bounded by ring fractures and faults and filled with a heterogeneous mixture of brecciated country rocks containing uranium minerals. The pipes were probably formed by solution collapse of underlying limestone or evaporites (Hilpert and Moench, 1960; McLemore, 1983; Wenrich, 1985).

More than 600 breccia-pipes are found in the Ambrosia and Laguna subdistricts, but only a few are uranium bearing (Hilpert, 1969; Nash, 1968; Moench, 1962). Pipe structures in the Cliffside (Clark and Havenstrite, 1963), Doris (Granger and Santos, 1963), and Jackpile-Paguate mines (Hilpert and Moench, 1960) have yielded ore as part of mining adjacent sandstone deposits; the exact tonnage attributed to these breccia-pipes is not known. Very little brecciation has occurred at the Cliffside and Doris pipes, however, these pipes appear to be related to other breccia pipes in the area. The Woodrow deposit is the largest uranium producer from a breccia-pipe in New Mexico (McLemore, 1983) and is 24 to 34 ft in diameter and at least 300 ft high. In Arizona, the mineralized Orphan Lode breccia-pipe is 150 to 500 ft in diameter and at least 1500 ft long (Gornitz and Kerr, 1970). More than 134,000 lbs of U_3O_8 at a grade of 1.26% U_3O_8 was produced from the Woodrow deposit. However, the New Mexico uraniferous collapse-breccia pipes are uncommon and much smaller in both size and grade than the Arizona uraniferous collapse-breccia pipes. Future mining potential of New Mexico breccia pipes is minimal.

Surficial uranium deposits

Ground-water anomalies and locally remote sensing data suggest that surficial or calcrete uranium deposits may exist in the Lordsburg Mesa area in southwestern New Mexico (Carlisle et al., 1978; Raines et al., 1985) and in the Ogalalla Formation in eastern New Mexico (Otton, 1984). However, mineralized zones high in uranium have not been found in these areas.

commonly associated with organic debris and other carbonaceous material.

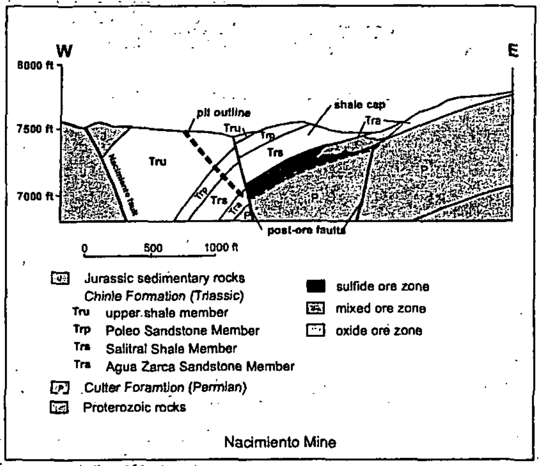

Figure 4. Cross section through Naciemento open pit mine exposing a sedimentary copper deposit (modified from Talbot, 1974).

Beach placer, thorium-rich sandstone uranium deposits

Heavy mineral, beach-placer sandstone deposits are concentrations of heavy minerals that formed on beaches or in longshore bars in a marginal-marine environment (Fig. 5; Houston and Murphy, 1970, 1977). Many beach-placer sandstone deposits contain high concentrations of Th, REE (rare earth elements), Zr, Ti, Nb, Ta, and Fe; U is rare, but only one deposit yielded minor uranium production (McLemore, 1983). Detrital heavy minerals comprise approximately 50-60% of the sandstones and typically consist of titanite, zircon, magnetite, ilmenite, monazite, apatite, and allanite, among others. These deposits in New Mexico are found in Cretaceous rocks, mostly in the San Juan Basin and are small (<3 ft thick), low tonnage, and low grade. They rarely exceed for more than several hundred feet in length, are only tens of feet wide, and 3-5 ft thick. However, collectively, the known deposits in the San Juan Basin contain 4,741,200 tons of ore containing 12.8% TiO_2, 2.1% Zr, 15.5% Fe and less than 0.10% ThO_2 (Dow and Batty, 1961). The small size and difficulty in recovering economic minerals will continue to discourage development of these deposits in the future.

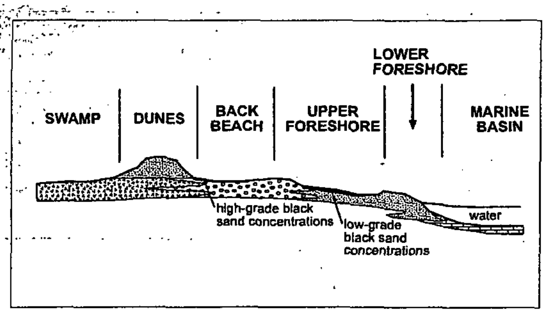

Figure 5. Idealized cross-section of formation of beach placer sandstone deposits (Houston and Murphy, 1970).

Limestone uranium deposits in the Todilto Formation (Jurassic)

Uranium is found only in a few limestones in the world, but the deposits in the Jurassic Todilto Limestone are some of the largest and most productive (Chenoweth, 1985a; Gabelman and Boyer, 1988). Uranium minerals were found in the Todilto Limestone in the early 1920s, although it was Paddy Martinez's discovery in 1950 that resulted in development of the Grants district. From 1950 through 1981, mines in the Grants district yielded 6,671,798 lbs of U_3O_8 from the Todilto Limestone, amounting to approximately 2% of the total uranium produced from the Grants district (Table 2; Chenoweth, 1985a; McLemore and Chenoweth, 1989, 1991).

Limestone is typically an unfavorable host rock for uranium because of low permeability and porosity and lack of precipitation agents, such as organic material. However, a set of unusual geological circumstances allowed the formation of uranium deposits in the Todilto Limestone. The organic-rich limestones were deposited in a sabkha environment on top of the permeable Entrada Sandstone. The overlying sand dunes of the Summerville or Wanakah Formation locally deformed the Todilto muds, producing the intraformational folds in the limestone. Uraniferous waters derived from a highland to the southwest migrated through the Entrada Sandstone. Ground water migrated into the Todilto Limestone by evapotranspiration or evaporative pumping. Uranium precipitated in the presence of organic material within the intraformational folds and associated fractures in the limestone (Fig. 6; Rawson, 1981; Finch and McLemore, 1989). The Todilto uranium deposits are 150-155 Ma, based on U-Pb isotopic dating, and are older than the 130 Ma Morrison sandstone uranium deposits (Berglof, 1989).

Uranium minerals, typically carnotite, are found in voids and fractures within lenticular deposits of alluvium, soil, or detritus that have been cemented by carbonate forming calcretes (Nash et al., 1981).

FUTURE POTENTIAL

New Mexico ranks 2nd in uranium reserves in the U.S. (behind Wyoming), which amounts to 15 million tons ore at 0.28% U_3O_8 (84 million lbs U_3O_8) at a forward cost of $30/lb and 238 million tons of ore at 0.076% U_3O_8 at a forward cost of $50/lb (Table 6, 7). The DOE classifies uranium reserves into forward cost categories of $30 and $50 U_3O_8 per pound. Forward costs are operating and capital costs (in current dollars) that are still to be incurred to produce uranium from estimated reserves. All of New Mexico's uranium reserves in 2006 are in the Morrison Formation in the San Juan Basin (Table 7); although uranium exploration is occurring elsewhere in New Mexico.

Only one company in New Mexico, Quivira Mining Co. (successor to Kerr McGee Corp., owned now by BHP-Billiton Plc.), produced uranium in 1989-2002, from waters recovered from inactive underground operations at Ambrosia Lake (mine-water recovery). Quivira Mining Co. is no longer producing uranium and the Ambrosia Lake mill and mines will be reclaimed in 2007. Any conventional mining of uranium in New Mexico will require a new mill or the ore would have to be shipped to the White Mesa mill in Blanding, Utah.

Rio Grande Resources Co. is maintaining the closed facilities at the flooded Mt. Taylor underground mine in Cibola County, where primary sandstone-hosted uranium deposits were mined as late as 1989 (Table 6). Reserves are estimated as 121 million pounds U_3O_8 at 0.25% U_3O_8, which includes 7.5 million pounds of U_3O_8 at 0.50% U_3O_8. Depths to ore average 3,300 ft.

The La Jara Mesa uranium deposit in Cibola County was originally owned by Homestake Mining Co and in 1997 was transferred to Anaconda and subsequently to Laramide Resources Ltd. This primary sandstone-hosted uranium deposit, discovered in the Morrison Formation in the late 1980s, contains approximately 8 million pounds of ore averaging 0.25% U_3O_8 (Table 6). It is above the water table and is not suited to current in situ leaching technologies. New Mexico Mining and Minerals Division has approved an exploration permit for Laramide Resources and a permit is pending for Urex Energy Corp., who also owns adjacent properties on Jara Mesa to Laramide. Laramide Resources also controls the nearby Melrich deposit (Table 6). Lakeview Ventures also acquired adjacent properties (press release, April 19, 2006).

Hydro Resources, Inc. (subsidiary of Uranium Resources Inc.) is waiting for final permit approvals and an increase in the price of uranium before mining uranium by in-situ leaching at Church Rock and Crownpoint. Production costs are estimated as $13.54 per pound of U_3O_8 (Pelizza and McCarn, 2002, 2003 a, b). Reserves at Church Rock (Section 8, 17) and Mancos mines are estimated as 19 million pounds of U_3O_8 (Table 6; Pelizza and McCarn, 2002, 2003 a, b). Hydro Resources, Inc. estimates production costs at Crownpoint to be $11.46-12.71 per pound U_3O_8 (Pelizza and McCarn, 2002, 2003 a, b). Hydro Resources, Inc. also owns the Santa Fe Railroad properties in the Ambrosia Lake subdistrict.

Strathmore Minerals Corp. has acquired numerous properties in the Grants district, including Roca Honda (33,300,000 pounds U_3O_8), Church Rock (15,300,000 pounds U_3O_8; Fitch, 2005), and Nose Rock. Strathmore hopes to mine uranium by both in situ leaching and conventional mining and milling. An exploration permit is pending for the Roca Honda deposit.

Quincy Energy Corp. merged with Energy Metals Corp. in July 2006, and acquired properties in Crownpoint (section 24 contains 9.966 million pounds of U_3O_8 and sections 19 and 29 contains 13.672 million pounds of U_3O_8; Myers, 2006a, b) and Hosta Butte (14.822 million pounds of U_3O_8; Myers, 2006c). Quincy Energy Corp. is examining the uranium resource potential in northeastern New Mexico.

An exploration permit was approved by New Mexico Mining and Minerals Division for Western Energy Development to drill at the Treeline project, Ambrosia Lake subdistrict, McKinley County. An exploration permit is pending for Urex to explore for uranium on their properties in the Grants district.

Max Resources Corp. has filed for drilling permits for the C de Baca property in the Riley area, Socorro County, where Occidental Minerals in 1981-1982 identified 1.67 million tons of U_3O_8 grading 0.18% U_3O_8, found in sandstones of the Cretaceous Crevasse Canyon and Tertiary Baca Formations (press release June 8, 2006).

SUMMARY

Sandstone uranium deposits in New Mexico have played a major role in historical uranium production. Although other types of uranium deposits in the world are higher in grade and larger in tonnage, the Grants uranium district could soon become a significant source of uranium:

- As in situ leaching technologies improve, decreasing production costs.
- As demand for uranium increases world-wide, increasing the price of uranium.

However, several challenges need to be overcome by the companies before uranium could be produced once again from the Grants uranium district:

- There are no conventional mills remaining in New Mexico to process the ore, which adds to the cost of producing uranium in the state. New infrastructure will need to be built before conventional mining can resume.
- Permitting for new in situ leaching and especially for conventional mines and mills will possibly take years to complete.
- Closure plans, including reclamation must be developed before mining or leaching begins. Modern regulatory costs will add to the cost of producing uranium in the U.S.
- Some communities, especially the Navajo Nation communities, do not view development of uranium properties as favorable. The Navajo Nation has declared that no uranium production will occur on Navajo lands.
- High-grade, low-cost uranium deposits in Canada and Australia are sufficient to meet current international demands; but additional resources will be required to meet near-term future requirements.

ACKNOWLEDGMENTS

Figure 1 was drafted by the NMBGMR Cartography Department. This paper is part of ongoing research of mineral resources in New Mexico and adjacent areas at NMBGMR, Peter Scholle, Director and State Geologist. John DeJoia, Dave Fitch, Clyde Yancey, Bill Brancard, Susan Lukas, and Bill Chenoweth reviewed an earlier version of this manuscript.

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U.S. Census Bureau
American FactFinder

FACT SHEET

McKinley County, New Mexico

2006 American Community Survey
Data Profile Highlights:

NOTE. Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

Social Characteristics - show more >>	**Estimate**	**Percent**	**U.S.**	**Margin of Error**
Average household size	3.44	(X)	2.61	+/-0.21
Average family size	4.29	(X)	3.20	+/-0.42
Population 25 years and over	38,579			+/-487
High school graduate or higher	(X)	68.9	84.1%	(X)
Bachelor's degree or higher	(X)	11.5	27.0%	(X)
Civilian veterans (civilian population 18 years and over)	N	N	10.4%	N
Disability status (population 5 years and over)	10,192	15.7	15.1%	+/-1,688
Foreign born	2,097	2.9	12.5%	+/-902
Male, Now married, except separated (population 15 years and over)	10,043	41.8	52.4%	+/-1,301
Female, Now married, except separated (population 15 years and over)	10,262	37.3	48.4%	+/-1,182
Speak a language other than English at home (population 5 years and over)	N	N	19.7%	N
Household population	69,791			+/-226
Group quarters population	(X)	(X)	(X)	(X)

Economic Characteristics - show more >>	**Estimate**	**Percent**	**U.S.**	**Margin of Error**
In labor force (population 16 years and over)	24,918	50.0	65.0%	+/-1,699
Mean travel time to work in minutes (workers 16 years and over)	21.6	(X)	25.0	+/-2.6
Median household income (in 2006 inflation-adjusted dollars)	27,261	(X)	48,451	+/-3,708
Median family income (in 2006 inflation-adjusted dollars)	32,402	(X)	58,526	+/-6,279
Per capita income (in 2006 inflation-adjusted dollars)	11,272	(X)	25,267	+/-1,043
Families below poverty level	(X)	36.8	9.8%	(X)
Individuals below poverty level	(X)	44.0	13.3%	(X)

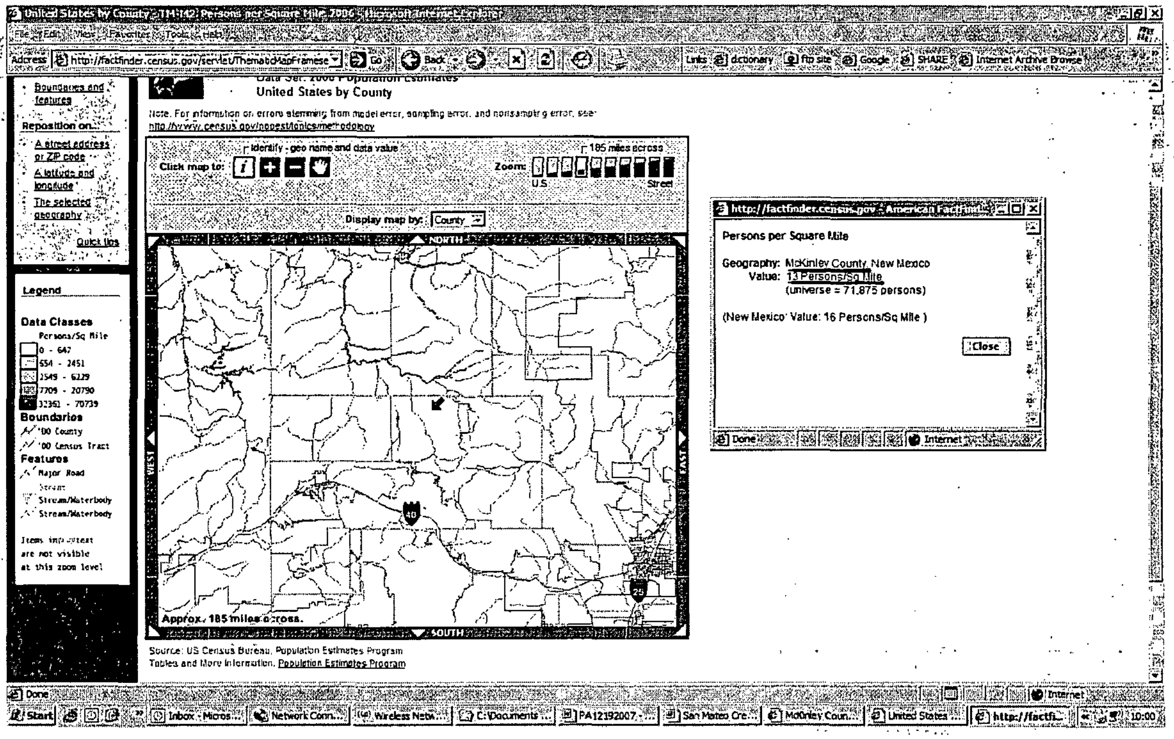
Housing Characteristics - show more >>	**Estimate**	**Percent**	**U.S.**	**Margin of Error**
Total housing units	27,580			+/-69
Occupied housing units	20,283	73.5	88.4%	+/-1,247
Owner-occupied housing units	15,657	77.2	67.3%	+/-1,234
Renter-occupied housing units	4,626	22.8	32.7%	+/-1,112
Vacant housing units	7,297	26.5	11.6%	+/-1,259
Owner-occupied homes	15,657			+/-1,234
Median value (dollars)	67,400	(X)	185,200	+/-7,144
Median of selected monthly owner costs				
With a mortgage (dollars)	734	(X)	1,402	+/-112
Not mortgaged (dollars)	201	(X)	399	+/-25

ACS Demographic Estimates - show more >>	**Estimate**	**Percent**	**U.S.**	**Margin of Error**
Total population	71,875			*****
Male	33,969	47.3	49.2%	+/-935

Female	37,906	52.7	50.8%	+/-935
Median age (years)	28.6	(X)	36.4	+/-0.7
Under 5 years	7,025	9.8	6.8%	+/-441
18 years and over	46,996	65.4	75.4%	*****
65 years and over	6,417	8.9	12.4%	+/-550
One race	70,322	97.8	98.0%	+/-1,080
White	14,599	20.3	73.9%	+/-1,638
Black or African American	784	1.1	12.4%	+/-748
American Indian and Alaska Native	53,114	73.9	0.8%	+/-1,149
Asian	293	0.4	4.4%	+/-326
Native Hawaiian and Other Pacific Islander	0	0.0	0.1%	+/-279
Some other race	1,532	2.1	6.3%	+/-905
Two or more races	1,553	2.2	2.0%	+/-1,080
Hispanic or Latino (of any race)	N	N	14.8%	N

Source: U.S. Census Bureau, 2006 American Community Survey

Explanation of Symbols:
'***' - The median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
'*****' - The estimate is controlled. A statistical test for sampling variability is not appropriate.
'N' - Data for this geographic area cannot be displayed because the number of sample cases is too small.
'(X)' - The value is not applicable or not available.



United States by County - TM-M2. Persons per Square Mile 2006 - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://factfinder.census.gov/servlet/ThematicMapFramese
Data Set: 2006 Population Estimates
United States by County
Note. For information on errors stemming from model error, sampling error, and nonsampling error, see
http://www.census.gov/popest/topics/methodology
Boundaries and features
Reposition on...
A street address or ZIP code
A latitude and longitude
The selected geography
Quick tips
Identify - geo name and data value
Click map to:
185 miles across
Zoom:
U.S.
Street
Display map by: County
NORTH
SOUTH
WEST
EAST
Approx. 185 miles across.
Legend
Data Classes
Persons/Sq Mile
Boundaries
'00 County
'00 Census Tract
Features
Major Road
Stream/Waterbody
Items in italics are not visible at this zoom level
Source: US Census Bureau, Population Estimates Program
Tables and More Information: Population Estimates Program
http://factfinder.census.gov - American FactFinder
Persons per Square Mile
Geography: McKinley County, New Mexico
Value: 13 Persons/Sq Mile
(universe = 71,875 persons)
(New Mexico' Value: 16 Persons/Sq Mile)
Close
Done
Internet
Start

1

2

Persons per Square Mile

Geography: Cibola County, New Mexico
Value: 6 Persons/Sq Mile
(universe = 27,481 persons)

(New Mexico: Value: 16 Persons/Sq Mile)

Close

U.S. Census Bureau
American FactFinder

FACT SHEET

Cibola County, New Mexico

View a Fact Sheet for a **race, ethnic, or ancestry group**

Census 2000 Demographic Profile Highlights:

General Characteristics - show more >>	**Number**	**Percent**	**U.S.**		
Total population	25,595			map	brief
Male	12,505	48.9	49.1%	map	brief
Female	13,090	51.1	50.9%	map	brief
Median age (years)	33.1	(X)	35.3	map	brief
Under 5 years	2,031	7.9	6.8%	map	
18 years and over	17,750	69.3	74.3%		
65 years and over	2,734	10.7	12.4%	map	brief
One race	24,767	96.8	97.6%		
White	10,138	39.6	75.1%	map	brief
Black or African American	246	1.0	12.3%	map	brief
American Indian and Alaska Native	10,319	40.3	0.9%	map	brief
Asian	98	0.4	3.6%	map	brief
Native Hawaiian and Other Pacific Islander	14	0.1	0.1%	map	brief
Some other race	3,952	15.4	5.5%	map	
Two or more races	828	3.2	2.4%	map	brief
Hispanic or Latino (of any race)	8,555	33.4	12.5%	map	brief
Household population	24,529	95.8	97.2%	map	brief
Group quarters population	1,066	4.2	2.8%	map	
Average household size	2.95	(X)	2.59	map	brief
Average family size	3.41	(X)	3.14	map	
Total housing units	10,328			map	
Occupied housing units	8,327	80.6	91.0%		brief
Owner-occupied housing units	6,414	77.0	66.2%	map	
Renter-occupied housing units	1,913	23.0	33.8%	map	brief
Vacant housing units	2,001	19.4	9.0%	map	

Social Characteristics - show more >>	**Number**	**Percent**	**U.S.**		
Population 25 years and over	15,273				
High school graduate or higher	11,461	75.0	80.4%	map	brief
Bachelor's degree or higher	1,835	12.0	24.4%	map	
Civilian veterans (civilian population 18 years and over)	2,633	14.9	12.7%	map	brief
Disability status (population 5 years and over)	4,817	21.3	19.3%	map	brief
Foreign born	583	2.3	11.1%	map	brief
Male, Now married, except separated (population 15 years and over)	4,787	52.5	56.7%		brief
Female, Now married, except separated (population 15 years and over)	4,802	48.4	52.1%		brief
Speak a language other than English at home (population 5 years and over)	10,363	43.9	17.9%	map	brief

Economic Characteristics - show more >>	**Number**	**Percent**	**U.S.**		
In labor force (population 16 years and over)	9,848	53.0	63.9%		brief
Mean travel time to work in minutes (workers 16 years and over)	23.5	(X)	25.5	map	brief
Median household income in 1999 (dollars)	27,774	(X)	41,994	map	
Median family income in 1999 (dollars)	30,714	(X)	50,046	map	
Per capita income in 1999 (dollars)	11,731	(X)	21,587	map	
Families below poverty level	1,365	21.5	9.2%	map	brief
Individuals below poverty level	6,054	24.8	12.4%	map	

Housing Characteristics - show more >>	**Number**	**Percent**	**U.S.**

Single-family owner-occupied homes	3,742				brief
Median value (dollars)	62,600	(X)	119,600	map	brief
Median of selected monthly owner costs	(X)	(X)			brief
With a mortgage (dollars)	654	(X)	1,088	map	
Not mortgaged (dollars)	179	(X)	295		

(X) Not applicable.
Source: U.S. Census Bureau, Summary File 1 (SF 1) and Summary File 3 (SF 3)

The letters PDF or symbol indicate a document is in the Portable Document Format (PDF). To view the file you will need the Adobe® Acrobat® Reader, which is available for **free** from the Adobe web site.

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Non-Coliform Sample Results

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	10500974	**Collection Date :**	11-30-2005

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	900	Y	MRL	1.96 PCI/L	0 PCI/L	01-01-2004	12-31-20(
4000	GROSS ALPHA, EXCL. RADON & U	900	Y	MRL	1.96 PCI/L	0 PCI/L	01-01-2004	12-31-20(
4010	COMBINED RADIUM (-226 & -228)	null	Y	MRL	1.36 PCI/L	0 PCI/L		
4010	COMBINED RADIUM (-226 & -228)	null	Y	MRL	1.36 PCI/L	0 PCI/L		
4020	RADIUM-226	903.1	Y	MRL	1.36 PCI/L	0.17 PCI/L	01-01-2004	12-31-20(
4020	RADIUM-226	903.1	Y	MRL	1.36 PCI/L	0.17 PCI/L	01-01-2004	12-31-20(
4030	RADIUM-228	904.0	Y	MRL	0.81 PCI/L	0 PCI/L	01-01-2004	12-31-20(
4030	RADIUM-228	904.0	Y	MRL	0.81 PCI/L	0 PCI/L	01-01-2004	12-31-20(
4100	GROSS BETA PARTICLE ACTIVITY	900	N	MRL	1.8 PCI/L	1.90 PCI/L	01-01-2004	12-31-20(
4100	GROSS BETA PARTICLE ACTIVITY	900	N	MRL	1.8 PCI/L	1.90 PCI/L	01-01-2004	12-31-20(

Total Number of Records Fetched = 10

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC200100576	**Collection Date :**	09-18-2001

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date
4020	RADIUM-226	null	N		0.02 PCI/L	.21 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.21 PCI/L		

Total Number of Records Fetched = 2

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Non-Coliform Sample Results

Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	8291DW1	**Collection Date :**	11-30-2005

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
4006	COMBINED URANIUM	200.8	Y	MRL	0.001 MG/L	null	01-01-2004	12-31-2007	30 UG/L

Total Number of Records Fetched = 1

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM963196	**Collection Date :**	11-19-1996

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
1005	ARSENIC	null	Y	MRL	0.001 MG/L	null			0.01 MG/L
1010	BARIUM	null	Y	MRL	0.1 MG/L	null			2 MG/L
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null			0.005 MG/L
1020	CHROMIUM	null	Y	MRL	0.001 MG/L	null			0.1 MG/L
1035	MERCURY	null	Y	MRL	0.0005 MG/L	null			0.002 MG/L
1036	NICKEL	null	Y	MRL	0.01 MG/L	null			0.1 MG/L
1045	SELENIUM	null	Y	MRL	0.005 MG/L	null			0.05 MG/L
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null			0.006 MG/L
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null			0.004 MG/L
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null			0.002 MG/L

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM199802280	**Collection Date :**	11-17-1998

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
1005	ARSENIC	200.8	Y	MRL	0.001 MG/L	null			0.01 MG/L
1010	BARIUM	200.8	N		0.1 MG/L	.4 MG/L			2 MG/L
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null			0.005 MG/L
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L	null			0.1 MG/L
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null			0.002 MG/L
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null			0.1 MG/L
1045	SELENIUM	200.9	Y	MRL	0.005 MG/L	null			0.05 MG/L
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null			0.006 MG/L
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null			0.004 MG/L
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null			0.002 MG/L

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200102180	**Collection Date :**	09-18-2001

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
1005	ARSENIC	null	Y	MRL	0.001 MG/L	null			0.01 MG/L
1010	BARIUM	null	N		0.1 MG/L	.4 MG/L			2 MG/L
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null			0.005 MG/L
1020	CHROMIUM	null	N		0.001 MG/L	.002 MG/L			0.1 MG/L
1035	MERCURY	null	Y	MRL	0.0002 MG/L	null			0.002 MG/L
1036	NICKEL	null	Y	MRL	0.01 MG/L	null			0.1 MG/L
1045	SELENIUM	null	Y	MRL	0.005 MG/L	null			0.05 MG/L
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null			0.006 MG/L
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null			0.004 MG/L
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null			0.002 MG/L

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200300038	**Collection Date :**	01-22-2003

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
1005	ARSENIC	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-2004	0.01 MG/L
1010	BARIUM	200.8	N	MRL	0.1 MG/L	0.4 MG/L	01-01-2002	12-31-2004	2 MG/L
1015	CADMIUM	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-2004	0.005 MG/L
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-2004	0.1 MG/L
1035	MERCURY	200.8	Y	MRL	0.0002 MG/L	null	01-01-2002	12-31-2004	0.002 MG/L
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null	01-01-2002	12-31-2004	0.1 MG/L
1045	SELENIUM	200.8	Y	MRL	0.005 MG/L	null	01-01-2002	12-31-2004	0.05 MG/L
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-2004	0.006 MG/L
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-2004	0.004 MG/L
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-2004	0.002 MG/L

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200300038	**Collection Date :**	01-22-2003

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
1005	ARSENIC	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-2004	0.01 MG/L
1010	BARIUM	200.8	N		0.1 MG/L	.4 MG/L	01-01-2002	12-31-2004	2 MG/L
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-2004	0.005 MG/L
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-2004	0.1 MG/L
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null	01-01-2002	12-31-2004	0.002 MG/L
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null	01-01-2002	12-31-2004	0.1 MG/L
1045	SELENIUM	200.9	Y	MRL	0.005 MG/L	null	01-01-2002	12-31-2004	0.05 MG/L
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-2004	0.006 MG/L
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-2004	0.004 MG/L
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-2004	0.002 MG/L

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200302138	**Collection Date :**	10-08-2003

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
1005	ARSENIC	200.8	Y	MRL	0.001 MG/L	MG/L			0.01 MG/L
1010	BARIUM	200.8	Y	MRL	0.1 MG/L	null			2 MG/L
1015	CADMIUM	200.8	Y	MRL	0.001 MG/L	MG/L			0.005 MG/L
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L	MG/L			0.1 MG/L
1035	MERCURY	200.8	Y	MRL	0.0002 MG/L	null			0.002 MG/L
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null			0.1 MG/L
1045	SELENIUM	200.8	Y	MRL	0.005 MG/L	null			0.05 MG/L
1074	ANTIMONY, TOTAL	200.8	N	MRL	0.001 MG/L	0.002 MG/L			0.006 MG/L
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L			0.004 MG/L
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L			0.002 MG/L

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	0607731-0002A	**Collection Date :**	07-31-2006

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date	MCL
1005	ARSENIC	200.8	Y	MRL	0.001 MG/L				0.01 MG/L
1010	BARIUM	200.8	N	MRL	0.0025 MG/L	0.426 MG/L			2 MG/L
1015	CADMIUM	200.8	Y	MRL	0.0005 MG/L				0.005 MG/L
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L				0.1 MG/L
1035	MERCURY	245.1	Y	MRL	0.2 UG/L				0.002 MG/L
1036	NICKEL	200.8	Y	MRL	0.0005 MG/L				0.1 MG/L
1045	SELENIUM	200.8	Y	MRL	0.005 MG/L				0.05 MG/L
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.005 MG/L				0.006 MG/L
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.0005 MG/L				0.004 MG/L
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.0005 MG/L				0.002 MG/L

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Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

This list displays Non-Coliform Samples for the last 2 years by default. If you need to search for a specific date range, use the following date fields (you can also pick a date from the pop-up calendar next to the field) and click on Search.

Sample Collection Date From To

SEARCH

Lab Sample No.	Type	Collection Date & Time	Sampling Point	Sample Location	Laboratory
0607731-0002A	RT	07-31-2006 11:10:00	SP257330001	DISTRIBUTION SYSTEM	ASSAGAI ANALYTICAL LABORATORIES INC
HM200302138	RT	10-08-2003 null	SP257330011	WELL #1	SCIENTIFIC LABORATORY DIVISION
HM200300038	RT	01-22-2003 14:53:00	SP257330021	WELL #2	SCIENTIFIC LABORATORY DIVISION
HM200300038	RT	01-22-2003 null	SP257330021	WELL #2	SCIENTIFIC LABORATORY DIVISION
HM200102180	RT	09-18-2001 10:16:00	SP257330021	WELL #2	SCIENTIFIC LABORATORY DIVISION
HM199802280	RT	11-17-1998 14:16:00	SP257330021	WELL #2	SCIENTIFIC LABORATORY DIVISION
HM963196	RT	11-19-1996 12:25:00	SP257330021	WELL #2	SCIENTIFIC LABORATORY DIVISION

Total Number of Records Fetched = 7

Drinking Water Bureau

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Water System Facilities

Sample Schedules

Coliform Sample Results

Coliform Sample Summary Results

Lead And Copper Sample Summary Results

Non-Coliform Samples/Results

Non-Coliform Samples/Results by Analyte

Violations/Enforcement Actions

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Water System Details

Water System No. :	NM3525733	**Federal Type :**	C
Water System Name :	SAN MATEO MDWCA	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
ORTEGA, LLOYD	null	AC	505-287-8108	PO Box 3228, MILAN, NM-87021	Not Available
GRIEGO, ALEX		OP	505-287-8277	PO Box 3228, MILAN, NM-87021	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	192

Service Connections

Type	Count
CB	61

Sources of Water

Name	Type Code	Status
WELL #1	WL	I
WELL #2	WL	A

Service Areas

Code	Name
R	RESIDENTIAL AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Water Type	Purchase Date	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

REFERENCES

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U.S. Census Bureau
American FactFinder

FACT SHEET

Grants city, New Mexico

View a Fact Sheet for a **race, ethnic, or ancestry group**

Census 2000 Demographic Profile Highlights:

General Characteristics - show more >>	**Number**	**Percent**	**U.S.**		
Total population	8,806			map	brief
Male	4,053	46.0	49.1%	map	brief
Female	4,753	54.0	50.9%	map	brief
Median age (years)	34.4	(X)	35.3	map	brief
Under 5 years	715	8.1	6.8%	map	
18 years and over	6,270	71.2	74.3%		
65 years and over	1,085	12.3	12.4%	map	brief
One race	8,420	95.6	97.6%		
White	4,947	56.2	75.1%	map	brief
Black or African American	143	1.6	12.3%	map	brief
American Indian and Alaska Native	1,054	12.0	0.9%	map	brief
Asian	81	0.9	3.6%	map	brief
Native Hawaiian and Other Pacific Islander	11	0.1	0.1%	map	brief
Some other race	2,184	24.8	5.5%	map	
Two or more races	386	4.4	2.4%	map	brief
Hispanic or Latino (of any race)	4,611	52.4	12.5%	map	brief
Household population	8,353	94.9	97.2%	map	brief
Group quarters population	453	5.1	2.8%	map	
Average household size	2.61	(X)	2.59	map	brief
Average family size	3.06	(X)	3.14	map	
Total housing units	3,626			map	
Occupied housing units	3,202	88.3	91.0%		brief
Owner-occupied housing units	2,145	67.0	66.2%	map	
Renter-occupied housing units	1,057	33.0	33.8%	map	brief
Vacant housing units	424	11.7	9.0%	map	

Social Characteristics - show more >>	**Number**	**Percent**	**U.S.**		
Population 25 years and over	5,356				
High school graduate or higher	4,119	76.9	80.4%	map	brief
Bachelor's degree or higher	718	13.4	24.4%	map	
Civilian veterans (civilian population 18 years and over)	970	15.5	12.7%	map	brief
Disability status (population 5 years and over)	1,362	17.7	19.3%	map	brief
Foreign born	383	4.4	11.1%	map	brief
Male, Now married, except separated (population 15 years and over)	1,728	59.3	56.7%		brief
Female, Now married, except separated (population 15 years and over)	1,832	49.0	52.1%		brief
Speak a language other than English at home (population 5 years and over)	3,107	38.4	17.9%	map	brief

Economic Characteristics - show more >>	**Number**	**Percent**	**U.S.**		
In labor force (population 16 years and over)	3,801	58.3	63.9%		brief
Mean travel time to work in minutes (workers 16 years and over)	17.1	(X)	25.5	map	brief
Median household income in 1999 (dollars)	30,652	(X)	41,994	map	
Median family income in 1999 (dollars)	33,464	(X)	50,046	map	
Per capita income in 1999 (dollars)	14,053	(X)	21,587	map	
Families below poverty level	446	19.4	9.2%	map	brief
Individuals below poverty level	1,810	21.9	12.4%	map	

Housing Characteristics - show more >>	**Number**	**Percent**	**U.S.**

U.S. Census Bureau
American FactFinder

FACT SHEET

Milan village, New Mexico

View a Fact Sheet for a **race, ethnic, or ancestry group**

Census 2000 Demographic Profile Highlights:

General Characteristics - show more >>	Number	Percent	U.S.		
Total population	1,891			map	brief
Male	941	49.8	49.1%	map	brief
Female	950	50.2	50.9%	map	brief
Median age (years)	29.8	(X)	35.3	map	brief
Under 5 years	163	8.6	6.8%	map	
18 years and over	1,274	67.4	74.3%		
65 years and over	194	10.3	12.4%	map	brief
One race	1,800	95.2	97.6%		
White	965	51.0	75.1%	map	brief
Black or African American	25	1.3	12.3%	map	brief
American Indian and Alaska Native	264	14.0	0.9%	map	brief
Asian	0	0.0	3.6%	map	brief
Native Hawaiian and Other Pacific Islander	0	0.0	0.1%	map	brief
Some other race	546	28.9	5.5%	map	
Two or more races	91	4.8	2.4%	map	brief
Hispanic or Latino (of any race)	989	52.3	12.5%	map	brief
Household population	1,891	100.0	97.2%	map	brief
Group quarters population	0	0.0	2.8%	map	
Average household size	2.81	(X)	2.59	map	brief
Average family size	3.33	(X)	3.14	map	
Total housing units	806			map	
Occupied housing units	673	83.5	91.0%		brief
Owner-occupied housing units	498	74.0	66.2%	map	
Renter-occupied housing units	175	26.0	33.8%	map	brief
Vacant housing units	133	16.5	9.0%	map	

Social Characteristics - show more >>	Number	Percent	U.S.		
Population 25 years and over	1,051				
High school graduate or higher	712	67.7	80.4%	map	brief
Bachelor's degree or higher	58	5.5	24.4%	map	
Civilian veterans (civilian population 18 years and over)	156	12.5	12.7%	map	brief
Disability status (population 5 years and over)	471	27.6	19.3%	map	brief
Foreign born	40	2.1	11.1%	map	brief
Male, Now married, except separated (population 15 years and over)	321	50.6	56.7%		brief
Female, Now married, except separated (population 15 years and over)	349	50.7	52.1%		brief
Speak a language other than English at home (population 5 years and over)	643	37.7	17.9%	map	brief

Economic Characteristics - show more >>	Number	Percent	U.S.		
In labor force (population 16 years and over)	761	58.6	63.9%		brief
Mean travel time to work in minutes (workers 16 years and over)	22.4	(X)	25.5	map	brief
Median household income in 1999 (dollars)	24,635	(X)	41,994	map	
Median family income in 1999 (dollars)	26,776	(X)	50,046	map	
Per capita income in 1999 (dollars)	10,463	(X)	21,587	map	
Families below poverty level	103	21.9	9.2%	map	brief
Individuals below poverty level	538	28.2	12.4%	map	

Housing Characteristics - show more >>	Number	Percent	U.S.

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NOTE:
To print data frame (right side), click on right frame before printing.

1971 - 2000

- Daily Temp. & Precip.
- Daily Tabular data (~23 KB)
- Monthly Tabular data (~1 KB)
- NCDC 1971-2000 Normals (~3 KB)

1961 - 1990

- Daily Temp. & Precip.
- Daily Tabular data (~23 KB)
- Monthly Tabular data (~1 KB)
- NCDC 1961-1990 Normals (~3 KB)

Period of Record

- Station Metadata
- Station Metadata Graphics

General Climate Summary Tables

- Temperature
- Precipitation
- Heating Degree Days

GRANTS AIRPORT, NEW MEXICO (293682)

Period of Record Monthly Climate Summary

Period of Record : 5/ 1/1953 to 6/30/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	46.4	51.5	58.4	67.5	76.5	86.5	88.4	85.1	79.8	69.4	56.4	47.3	67.8
Average Min. Temperature (F)	14.5	18.7	24.0	30.3	39.0	47.6	55.1	53.1	44.6	32.8	22.1	14.4	33.0
Average Total Precipitation (in.)	0.50	0.44	0.55	0.47	0.53	0.56	1.71	2.03	1.31	1.11	0.58	0.63	10.40
Average Total SnowFall (in.)	2.6	2.2	1.7	0.4	0.0	0.0	0.0	0.0	0.0	0.4	1.0	4.1	12.3
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.
Max. Temp.: 96.2% Min. Temp.: 96.3% Precipitation: 96.1% Snowfall: 93.2% Snow Depth: 91.7%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

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State Map | Western U.S. map | Home Page

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- Daily Temp. & Precip.
- Daily Tabular data (~23 KB)
- Monthly Tabular data (~1 KB)
- NCDC 1961-1990 Normals (~3 KB)

Period of Record

- Station Metadata
- Station Metadata Graphics

General Climate Summary Tables
- Temperature
- Precipitation
- Heating Degree Days

SAN MATEO, NEW MEXICO (297918)

Period of Record Monthly Climate Summary

Period of Record : 4/ 1/1918 to 2/29/1988

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	40.6	44.6	51.6	60.9	70.7	81.0	83.1	79.6	73.1	62.9	50.9	41.4	61.7
Average Min. Temperature (F)	16.0	19.1	25.2	30.7	40.5	50.0	55.3	53.3	46.5	35.9	25.3	17.0	34.6
Average Total Precipitation (in.)	0.34	0.28	0.37	0.31	0.48	0.48	1.68	2.11	1.12	0.76	0.45	0.28	8.66
Average Total SnowFall (in.)	2.2	1.5	1.1	0.0	0.2	0.0	0.0	0.0	0.0	0.2	1.4	3.1	9.7
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.
Max. Temp.: 30.1% Min. Temp.: 31.1% Precipitation: 42.3% Snowfall: 27.1% Snow Depth: 26%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

REFERENCES

25-28

Prevailing wind direction is based on the hourly data from 1992-2002 and is defined as the direction with the highest percent of frequency. Many of these locations have very close secondary maximum which can lead to noticeable differences month to month.

Click on a State: Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

All directions are where the wind blows FROM.

ALASKA

PREVAILING WIND DIRECTION

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
AMBLER AIRPORT, AK. (PAFM)	NNE	NNE	NNE	NNE	NNE	W	NNE	NNE	NNE	NNE	NNE	NNE	NNE
ANAKTUVUK PASS AP, AK (PAKP)	NE	S	NNE	NE	NE	NE	NE	NE	NE	NE	S	NE	NE
ANCHORAGE INT'L AP, AK (PANC)	N	N	N	S	S	S	S	S	S	N	N	N	N
ANIAK, AK. (PANI)	N	ESE	N	ESE	W	SE	SE	SE	ESE	ESE	ESE	N	ESE
ANNETTE AP, AK (PANT). WIND	ESE	ESE	ESE	SE	SE	SE	SE	SE	SE	ESE	ESE	ESE	ESE
ANVIK AP, AK (PANV). WIND R	NE	NE	NNE	NNE	W	W	W	W	W	NNE	NE	NE	NE
ARCTIC VILLAGE AP, AK (PARC)	NE	E	ENE	E	E	NE	WSW	WSW	NE	E	E	E	E
BARROW, AK. (PABR)	ENE	E	E	E	E	E	E	E	E	E	E	ENE	E
BARTER ISLAND, AK. (PABA)	W	E	W	E	E	E	E	E	E	E	E	W	E
BETHEL AIRPORT, AK. (PABE)	NNE	NE	NNE	N	S	S	S	S	S	N	NNE	NNE	NNE
BETTLES AP, AK. (PABT)	N	NNW	N	N	N	SW	S	S	N	N	N	N	N
BIRCHWOOD, AK. (PABV)	S	S	SSW	W	W	W	W	W	SSW	SSW	S	S	SSW
BUCKLAND AP, AK. (PABL)	WNW	E	E	W	WNW	WNW	SE	W	SE	SE	SE	E	SE
CANTWELL AP, AK (PATW). WIN	Incomplete Data												
CAPE LISBURNE AP, AK (PALU).	E	E	E	E	E	E	SSW	SSW	E	ENE	E	E	E
CAPE NEWENHAM, AK (PAEH). W	ESE	ESE	ESE	N	S	S	S	S	N	N	ESE	N	N
CAPE ROMANZOF, AK. (PACZ)	NE	NNE	NE	NNE	S	NNE	SSW	N	N	NNE	NE	N	NNE
CHIGNIK AP, AK (PAJC). WIND	W	W	W	W	W	W	W	W	W	W	W	W	W
COLD BAY, AK. (PACD)	SE	SE	SE	SE	SE	SE	SE	W	W	N	SE	N	SE
CORDOVA, AK. (PACV)	E	E	E	E	E	E	ENE	ENE	E	E	E	E	E
DEADHORSE AP, AK (PASC). WI	WSW	ENE	ENE	E	E	E	ENE	E	E	E	E	WSW	E
DEERING AIRPORT, AK. (PADE)	W	E	W	W	W	W	W	SSW	SW	SW	E	W	W
DELTA JCT/FT GREELEY,(PABI)	ESE	ESE	E	S	W	W	W	W	E	E	ESE	ESE	ESE
DILLINGHAM AIRPORT, AK. (PADL	N	N	N	N	N	S	S	S	N	N	N	N	N
EAGLE AP, AK (PAEG). WIND R	ESE	ESE	SE	SE	NE	N	W	ESE	SE	ESE	ESE	ESE	ESE
EGEGIK AP, AK (PAII). WIND	N	ESE	ESE	ESE	W	ESE	SE	W	W	N	N	N	ESE
EIELSON AFB-FAIRBANKS,AK-PAEI	S	S	NNW	W	W	W	W	W	S	S	S	S	S
ELMENDORF AFB-ANCH, AK-PAED	NE	N	N	N	W	W	W	W	N	N	NNE	NE	N
EMMONAK, AK (PAEM). WIND RO	ENE	ENE	ENE	N	N	N	S	S	N	N	ESE	N	N

BOZEMAN-BELGRADE AP, MT (KBZ	S	SSE	SSE	W	SE	W	SSE	SSE	SE	SE	SSE	SSE	SSE
BUTTE AP, MT (KBTM). WIND R	S	S	S	N	N	N	N	S	S	S	S	S	S
CUT BANK AP, MT (KCTB). WIN	WSW	WSW	WSW	W	W	W	W	W	W	WSW	WSW	WSW	WSW
DILLON AP, MT (KDLN). WIND	S	S	S	S	S	S	S	S	S	S	S	S	S
GLASGOW AIRPORT, MT (KGGW).	ESE	ESE	E	E	E	E	E	E	E	ESE	E	ESE	E
GLENDIVE AIRPORT, MT (KGDV).	S	S	S	NW	NW	W	NW	S	NW	S	S	S	S
GREAT FALLS AP, MT (KGTF).	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
GREAT FALLS-MALSTROM AFB, MT	SW	SW	SW	SW	SW	W	W	W	SW	SW	SW	SW	SW
HAVRE AIRPORT, MT (KHVR). W	SW	SW	SW	E	E	E	E	E	SW	SW	SW	SW	SW
HELENA AIRPORT, MT (KHLN).	W	W	W	W	W	W	W	W	W	W	W	W	W
JORDAN AIRPORT, MT (KJDN).	W	W	W	W	W	W	W	W	W	W	W	W	W
KALISPELL AP, MT (KFCA). WI	S	S	SSE	SSE	SSE	SSE	SSE	S	S	S	S	S	S
LEWISTOWN AIRPORT, MT (KLWT)	SW	W	W	WNW	E	ESE	ESE	ESE	ESE	W	SW	SW	W
LIVINGSTON AP, MT (KLVM). W	WSW	WSW	W	W	W	W	W	W	W	W	WSW	WSW	W
MILES CITY AP, MT (KMLS). W	S	S	NW	NW	NW	NW	NW	SSE	NW	S	S	S	NW
MISSOULA AIRPORT, MT (KMSO).	ESE	ESE	N	NW	N	NW	N	N	N	W	ESE	ESE	NW
SIDNEY MUNI AP, MT (KSDY).	SSW	S	S	N	S	S	S	S	S	S	SSW	SSW	S
WOLF POINT AP, MT (KOLF). W	W	W	ENE	E	W	W	E	E	E	W	W	W	W

NEVADA

PREVAILING WIND DIRECTION

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
CALIENTE AP, NV (KP38). WIN	NNE	S	S	S	S	S	S	S	S	S	NNE	NNE	S
DESERT ROCK-MERCURY, NV (KDR	NNE	NNE	NNE	NNE	SW	SW	SW	SSW	SSW	NNE	NNE	NNE	SSW
ELKO AIRPORT, NV (KEKO). WI	E	E	W	W	W	W	W	W	W	W	E	E	W
ELY AIRPORT, NV (KELY). WIN	S	S	S	S	S	S	S	S	S	S	S	S	S
EUREKA AIRPORT, NV (KP68).	SSE	SSE	S	S	S	S	S	S	S	S	S	S	S
FALLON NAS, NV (KNFL). WIND	S	S	S	N	W	N	W	WNW	N	N	S	S	S
LAS VEGAS AIRPORT, NV (KLAS)	W	W	W	SW	SW	S	S	S	S	W	W	W	S
LAS VEGAS-NELLIS AFB, NV (KL	NE	NE	S	S	S	S	S	S	S	NNE	NNE	NE	S
LOVELOCK AIRPORT, NV (KLOL).	NNE	NNE	NNE	N	W	W	S	S	NE	NNE	E	NE	NNE
NORTH LAS VEGAS AP, NV (KVGT	NW	NW	NNW	SSW	S	S	S	S	NW	NW	NNW	NW	NW
RENO-TAHOE AP, NV (KRNO). W	S	S	W	W	W	W	W	W	W	S	S	S	W
TONOPAH AIRPORT, NV (KTPH).	N	N	N	N	N	N	S	N	N	N	N	N	N
WINNEMUCCA AP, NV (KWMC). W	S	S	S	W	W	W	W	W	W	S	S	S	S

NEW MEXICO

PREVAILING WIND DIRECTION

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
ALAMOGORDO-HOLLOMAN AFB, NM	S	S	S	S	S	S	S	S	S	S	SSE	N	S
ALBUQUERQUE-DOUBLE EAGLE II	NNW	NW	W	W	W	S	S	S	NNW	S	NNW	NNW	W
ALBUQUERQUE INT'L AP, NM (KA	N	N	N	W	W	E	E	E	E	N	N	N	N
ARTESIA AP, NM (KATS). WIND	WSW	SSE	SSE	SSE	SSE	SSE	SSE	SSE	SSE	SSE	SSE	N	SSE
CARLSBAD AP, NM (KCNM). WIN	W	W	W	W	W	SSE	S	SSE	S	S	W	W	S
CLAYTON MUNI AP, NM (KCAO).	W	N	N	N	S	S	S	S	S	S	W	WSW	S
CLINES CORNERS, NM (KCQC).	WNW	WNW	W	W	W	W	W	W	W	W	WNW	WNW	W
CLOVIS MUNI AP, NM (KCVN).	W	W	W	W	S	S	S	S	S	S	W	W	S
CLOVIS-CANNON AFB, NM (KCVS)	W	W	W	W	S	S	S	S	S	W	W	W	W
DEMING AP, NM (KDMN). WIND	W	W	W	W	W	W	E	E	E	W	W	W	W
FARMINGTON AP, NM (KFMN). W	E	E	W	W	W	E	E	E	E	E	E	E	E
GALLUP AIRPORT, NM (KGUP).	WSW	WSW	WSW	WSW	WSW	WSW	WSW	S	WSW	WSW	WSW	SW	WSW
GRANTS AIRPORT, NM (KGNT).	NW	NW	NW	W	W	W	SE	SE	NW	NW	NW	NW	NW
HOBBS AIRPORT, NM (KHOB). W	WSW	S	S	S	S	S	S	S	S	S	S	S	S
LAS CRUCES AP, NM (KLRU). W	W	W	W	W	W	W	SE	W	SE	W	W	W	W
LAS VEGAS AP, NM (KLVS). WI	S	S	S	S	S	S	S	SSW	S	S	S	S	S
LOS ALAMOS AP, NM (KLAM). W	S	S	S	S	S	S	S	S	S	S	S	S	S
RATON MUNI AP, NM (KRTN). W	ENE	NE	N	W	S	S	N	N	N	S	ENE	NE	N
ROSWELL AIRPORT, NM (KROW).	N	SSE	SSE	S	S	SSE	SSE	SSE	SSE	SSE	N	N	SSE
RUIDOSO AIRPORT, NM (KSRR).	W	W	W	SSW	SSW	SSW	ESE	ESE	ESE	W	W	W	W
SANTA FE AIRPORT, NM (KSAF).	N	N	N	N	WSW	N	N	N	N	N	N	N	N
SILVER CITY AP, NM (KSVC).	W	W	W	W	W	W	WNW	NNW	W	NNW	NNW	NNW	W
TAOS MUNI AIRPORT, NM (KSKX)	N	N	N	W	W	W	N	N	N	N	N	N	N
TRUTH OR CONSEQUENCES AP, NM	NW	S	S	S	S	S	S	WNW	S	S	NW	N	S

OREGON

PREVAILING WIND DIRECTION

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
ASTORIA AIRPORT, OR (KAST).	E	E	E	S	W	W	NW	NW	NW	E	E	E	E
AURORA AIRPORT, OR (KUAO).	S	S	S	S	S	S	N	N	N	S	S	S	S
BAKER CITY AP, OR (KBKE). W	ESE	ESE	ESE	N	N	NNW	NNW	NNW	NNW	N	ESE	ESE	NNW
BURNS MUNI AP, OR (KBNO). W	E	E	WNW	NW	NW	WNW	WNW	WNW	WNW	WNW	E	E	WNW
CORVALLIS AP, OR (KCVO). WI	S	S	S	S	WNW	NW	NW	NW	WNW	S	S	S	S
EUGENE AIRPORT, OR (KEUG).	S	S	S	S	N	N	N	N	N	S	S	S	N
HERMISTON MUNI AP, OR (KHRI)	WSW	S	WSW	WSW	WSW	WSW	WSW	WSW	SW	WSW	S	WSW	WSW
KLAMATH FALLS AP, OR (KLMT).	SSE	SSE	W	W	W	W	W	W	NNW	W	SSE	SSE	W
LA GRANDE AP, OR (KLGD). WI	S	S	S	NW	NW	NW	NW	NW	NW	S	S	S	S

Mayerson, David, NMENV

From:	Cox, Al (Grants) [ACox@barrick.com]
Sent:	Monday, December 31, 2007 11:37
To:	Mayerson, David, NMENV
Cc:	Mercer, Lena (Grants); Venable, Adrian (Grants); Kump, Dan (Grants)
Subject:	RE: Request for information
Follow Up Flag:	Follow up
Flag Status:	Red

Dave,
Yes, we do collect that data at the site, but it is in raw data form. There is also historic information for the Anaconda Bluewater site - the Grants airport met data is not representative of what conditions are at the Grants site itself.
We can discuss if you like - I will be back in office on Jan 2-4 and then on travel for all of the following week.

Have a great New Year's!!...........Al

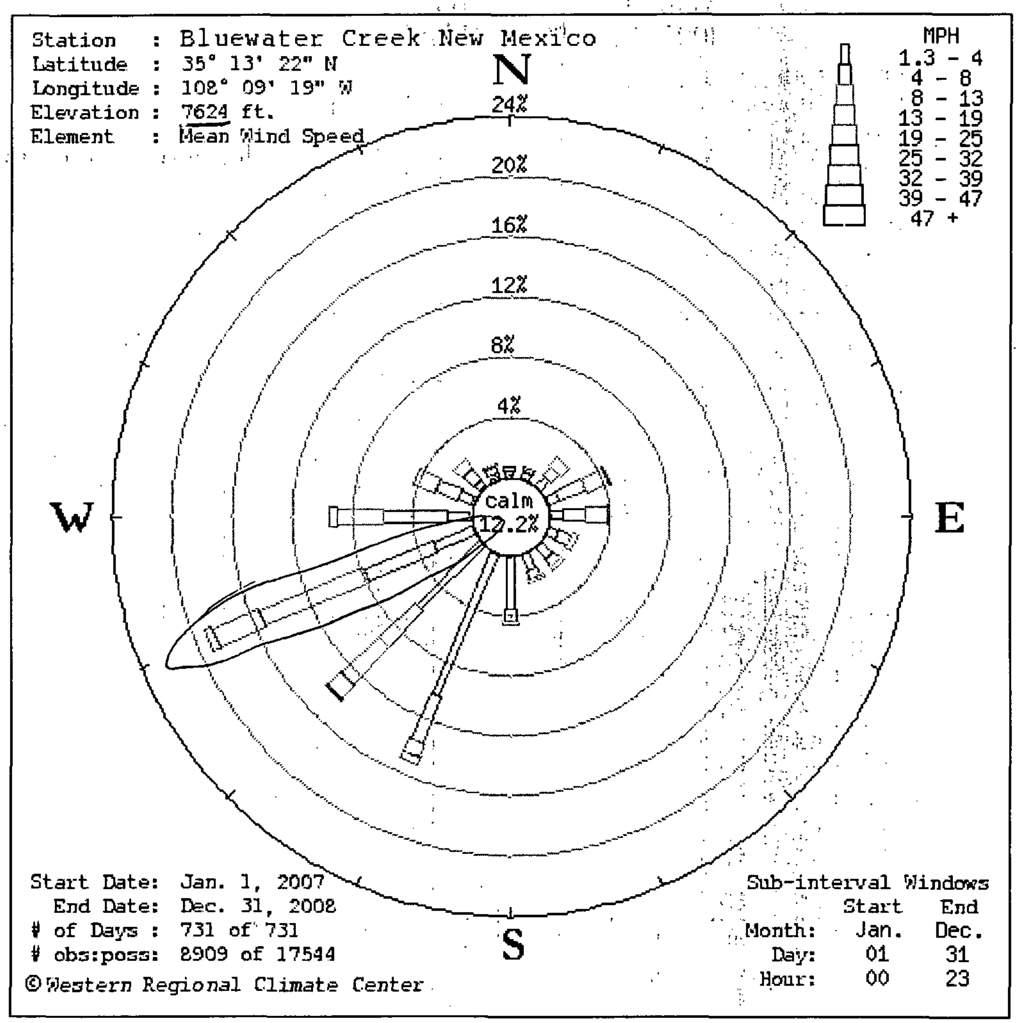
From: Mayerson, David, NMENV [mailto:David.Mayerson@state.nm.us]
Sent: Friday, December 28, 2007 4:10 PM
To: Cox, Al (Grants)
Subject: Request for information

Hi Al: I hope that you had a good holiday.

I am looking for some historical wind direction data for your area. Do you collect that type of data at your site?
Thanks.

David L. Mayerson
New Mexico Environment Department
Water and Waste Management Division
Ground Water Quality Bureau
Superfund Oversight Section
1190 St. Francis Drive
Suite N2312
POB 26110
Santa Fe, NM 87505
(505) 476-3777
(505) 827-2965
david.mayerson@state.nm.us
Normal work hours: Monday-Thursday 0700-1730

Bluewater Creek New Mexico



Bluewater Creek New Mexico - Wind Frequency Table (percentage)

Sub Interval Windows
Start End

Latitude : 35° 13' 22" N
Longitude : 108° 09' 19" W

Start Date : Jan. 1, 2007
End Date : Dec. 31, 2008

Elevation : 7624 ft.
Element :

# of Days : 731 of 731
obs : poss : 8909 of 17544

Month	Jan.	Dec.
Day	01	31
Hour	00	23

(Greater than or equal to initial interval value and Less than ending interval value.)

Range (mph)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
1.3 - 4	0.4	0.4	0.8	0.8	0.9	0.7	1.0	1.1	3.5	10.2	5.9	2.7	1.6	0.9	0.4	0.3	31.6
4 - 8	0.3	0.3	0.8	1.9	1.4	0.9	0.6	0.6	0.8	3.4	3.3	5.0	4.2	1.7	0.9	0.4	26.3
8 - 13	0.0	0.0	0.7	1.6	1.5	0.4	0.3	0.3	0.4	0.9	3.5	7.5	3.1	1.5	0.8	0.2	22.7
13 - 19	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.5	1.2	3.4	0.6	0.1	0.0	0.0	6.2
19 - 25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.1	0.0	0.0	0.0	0.8
25 - 32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
32 - 39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39 - 47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47 -	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total(%)	0.7	0.8	2.3	4.4	3.9	2.0	2.0	2.0	4.7	15.0	14.1	19.1	9.5	4.2	2.2	0.9	87.8
Calm (<1.3)																	12.2
Ave Speed	3.9	4.4	5.7	6.8	6.7	5.4	4.6	4.5	3.8	4.0	6.3	9.0	7.1	6.5	6.7	5.4	5.6

Bluewater Creek New Mexico - Hourly Wind Statistics Table

Latitude : 35° 13' 22" N
Longitude : 108° 09' 19" W
Elevation : 7624 ft.
Element :

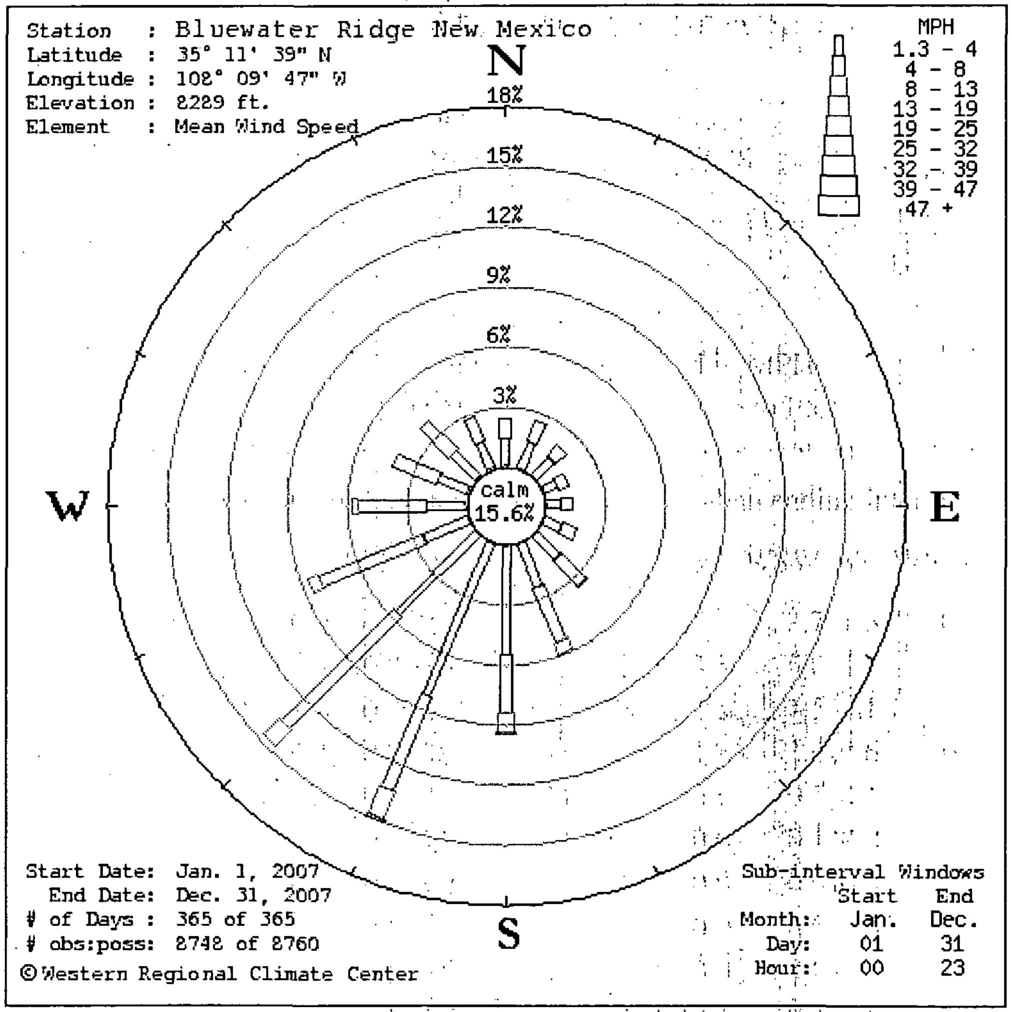
Start Date : Jan. 1, 2007
End Date : Dec. 31, 2008
# of Days : 731 of 731
obs : poss : 8909 of 17544

Sub Interval Windows

	Start	End
Month	Jan.	Dec.
Day	01	31
Hour	00	23

Time	- Time of Day (L.S.T.)
Speed	- Average (Scalar) Speed in MPH
U-Vel	- East-West Velocity, Positive to East
V-Vel	- North-South Velocity, Positive to North

Bluewater Ridge New Mexico



Bluewater Ridge New Mexico - Wind Frequency Table (percentage)

Sub Interval Windows
Start End

Latitude : 35° 11' 39" N
Longitude : 108° 09' 47" W

Start Date : Jan. 1, 2007
End Date : Dec. 31, 2007

Elevation : 8289 ft.
Element :

\# of Days : 365 of 365
\# obs : poss : 8748 of 8760

Month	Jan.	Dec.
Day	01	31
Hour	00	23

(Greater than or equal to initial interval value and Less than ending interval value.)

Range (mph)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
1.3 - 4	1.4	1.4	1.2	0.7	0.8	1.0	1.7	2.4	5.5	8.2	5.6	2.4	1.9	1.6	1.7	1.4	38.6
4 - 8	1.0	1.2	0.7	0.5	0.6	0.8	1.7	2.9	2.8	5.1	7.9	5.6	3.4	2.4	2.0	1.3	40.1
8 - 13	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.0	1.5	1.1	0.6	0.3	0.1	0.0	0.0	5.3
13 - 19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
19 - 25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25 - 32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32 - 39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39 - 47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47 -	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total(%)	2.4	2.5	2.0	1.3	1.4	1.8	3.5	5.9	9.5	14.9	14.7	8.5	5.7	4.0	3.7	2.7	84.3
Calm (<1.3)																	15.6
Ave Speed	3.5	3.6	3.5	3.7	3.9	4.1	4.1	4.6	4.3	4.3	4.5	4.7	4.5	4.2	3.8	3.7	3.6

Bluewater Ridge New Mexico - Hourly Wind Statistics Table

Latitude : 35° 11' 39" N
Longitude : 108° 09' 47" W
Elevation : 8289 ft.
Element :

Start Date : Jan. 1, 2007
End Date : Dec. 31, 2007
\# of Days : 365 of 365
\# obs : poss : 8748 of 8760

Sub Interval Windows

	Start	End
Month	Jan.	Dec.
Day	01	31
Hour	00	23

Time - Time of Day (L.S.T.)
Speed - Average (Scalar) Speed in MPH
U-Vel - East-West Velocity, Positive to East
V-Vel - North-South Velocity, Positive to North

REFERENCES

29-32

Metadata for Land Ownership

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Bluewater, New Mexico, Disposal Site

FACT SHEET

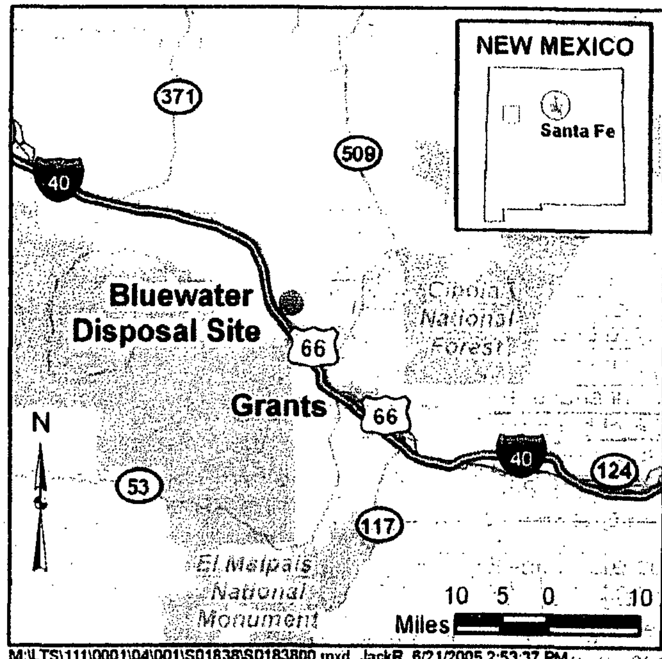
This fact sheet provides information about the Uranium Mill Tailings Radiation Control Act of 1978 Title II disposal site at Bluewater, New Mexico. This site is managed by the U.S. Department of Energy Office of Legacy Management.

Site Description and History

The Bluewater Disposal Site is in Cibola County in west-central New Mexico. Anaconda Copper Company constructed the original carbonate-leach mill at the site in 1953 to process uranium ore. The mill had a production capacity of 300 tons of ore per day. A discovery of sandstone uranium ores in the area led to construction of an acid-leach mill at the site that began operations in 1957. The carbonate-leach mill closed in 1959, and production in the acid-leach mill was reduced for economic reasons. The acid-leach mill resumed full operations in 1967, and the capacity of the mill had increased to 6,000 tons of ore per day by 1978. Milling operations at the site ended on February 14, 1982. In 1986, the Anaconda Copper Company became the Atlantic Richfield Company (ARCO).

Uranium-ore processing at the Bluewater mill produced radioactive tailings, a predominantly sandy material. The tailings were conveyed in slurry from the mill to two locations, depending on the milling method. The acid-leach tailings were segregated from the carbonate-leach tailings to prevent chemical reactions from occurring as a result of mixing acidic and basic compounds. Process water in the tailings slurry leached into the underlying San Andres aquifer and contaminated the ground water; the main constituents of concern are molybdenum, selenium, and uranium.

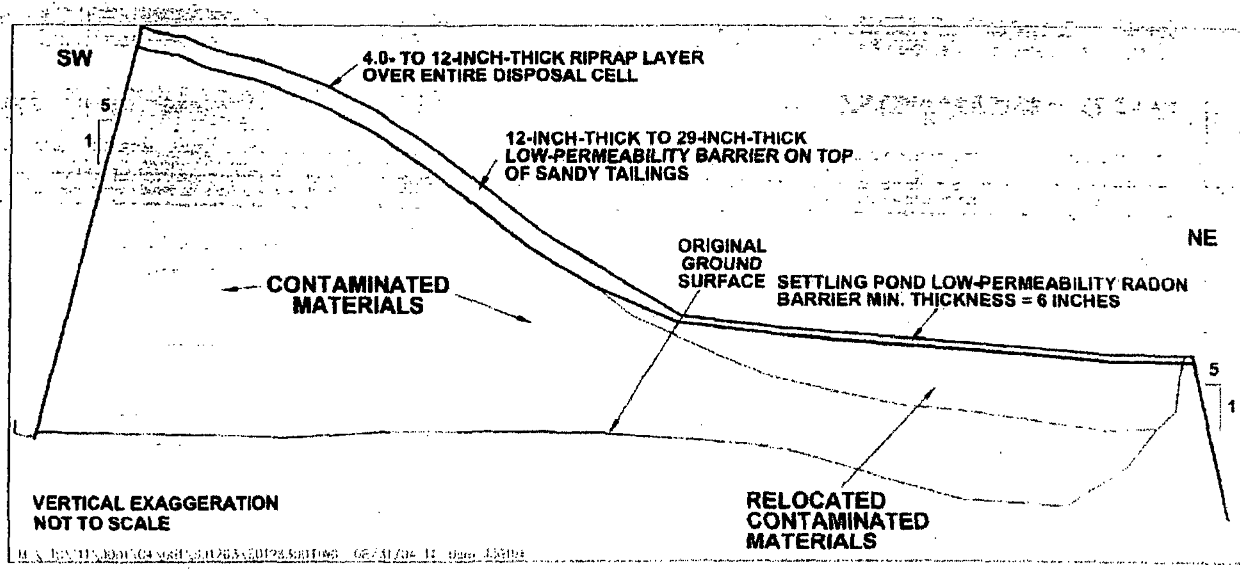
ARCO began decommissioning the mill in 1989 and began site reclamation in 1991. By 1995, all mill tailings, contaminated soils, demolished mill structures, and contaminated vicinity property materials were encapsulated in three on-site disposal areas. These areas are the main disposal cell, which comprises the acid tailings and the contiguous south bench disposal area; the carbonate tailings cell and a contiguous asbestos disposal area; and the polychlorinated biphenyl (PCB) disposal cell, which contains uranium mill tailings and soils mixed with PCBs. More than 80 percent of the total tailings material is encapsulated in the main disposal cell.



Location of the Bluewater Disposal Site

Regulatory Setting

Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) in 1978 (Public Law 95-604). The Bluewater site is under the jurisdiction of Title II of UMTRCA, which applies to uranium millsites that were under active U.S. Nuclear Regulatory Commission (NRC) license when UMTRCA was passed. Title II of the legislation specifies that after reclamation is completed, long-term custody of the site is the responsibility of either the federal government or the host state, at the option of the state. New Mexico declined to become the long-term custodian of the Bluewater site, and the U.S. Department of Energy (DOE) assumed custodial responsibility. Under Title II of UMTRCA, the licensee, ARCO, was responsible for remedial action. NRC's cleanup and reclamation standards are promulgated in Title 10 *Code of Federal Regulations* (CFR) Part 40, Appendix A. These standards conform to U.S. Environmental Protection Agency (EPA) standards in 40 CFR 192. The site was



Southwest-Northeast Cross Section of the Main Disposal Cell at the Bluewater Disposal Site

included under NRC's general license for long-term custody in 1997. At that time, title to the site transferred from ARCO to DOE.

Disposal Site

The site comprises 3,300 acres; about one-third of which (the southern and western parts) is covered by basalt that may have flowed as recently as 2,000 to 4,000 years ago. Much of the remainder of the site is covered with fine-grained material deposited by wind and water. The region around the disposal site is sparsely populated, and the main land use near the site is grazing. A barbed-wire perimeter fence encloses the entire site.

Compliance Strategy

Several years of active treatment by pumping contaminated ground water from the aquifer produced no significant reduction in concentrations of molybdenum, selenium, and uranium. In 1990, ARCO applied to NRC for alternate concentration limits. Alternate concentration limits may be adopted within specified areas when established maximum concentration limits are unattainable, providing the alternate concentration limits do not pose a present or potential future hazard to human health or the environment. NRC approved the application in 1996.

PCB-contaminated waste was discovered during reclamation of the mill. At the time of the discovery, no commercial waste disposal facility in the United States was licensed to accept radioactive waste contaminated with PCBs. These wastes were regulated under the Toxic Substances Control Act, which is under EPA's jurisdiction. ARCO proposed encapsulating the wastes on site in a separate disposal cell. After resolution of several issues, EPA agreed to issue a permit for the proposed disposal approach, provided that ARCO conducted ground water monitoring and maintained the appropriate records. DOE concurred with the disposal subject to an indemnification agreement whereby ARCO agreed to cover future costs that may result from the PCB disposal.

The compliance strategy includes annual ground water monitoring at nine monitor wells located inside the site boundary. Samples are analyzed annually for PCBs and every 3 years for molybdenum, selenium, and uranium.

Disposal Cell Design

The main disposal cell covers about 320 acres and contains an estimated 23 millions tons (16 million cubic yards) of tailings and other contaminated materials having a total activity of about 11,200 curies of radium-226. The cover of the main disposal cell is a two-layer system designed to encapsulate and protect the contaminated materials. The cover consists of a low-permeability radon barrier (first layer placed over compacted tailings) and a rock (riprap) erosion protection layer.

The carbonate tailings cell covers about 65 acres and contains an estimated 1.3 million tons (930,000 cubic yards) of contaminated materials having a total activity of about 1,130 curies of radium-226. Layers of barrier material and riprap similar to those on the main disposal cell also cover the carbonate tailings cell to protect the cover from erosion.

The PCB disposal cell is less than 1 acre and contains PCB-contaminated material sealed in 144 drums placed on a 3-foot-thick clay liner. Voids between the drums were filled with a soil-cement mixture to prevent

Rio Algom - Ambrosia Lake

1.0 Site Identification

Location:	Grants, NM
License No.:	SUA-1473
Docket No.:	40-8905
License Status:	Possession Only License
Project Manager:	Tom McLaughlin

2.0 Site Status Summary

This is a uranium mill tailings site in the Ambrosia Lake uranium district of New Mexico. It is location approxin miles north of Grants, New Mexico. The tailings impoundment contains 33 million tons of uranium ore and cov approximately 370 acres.

The site status changed from standby to reclamation in August 2003 to reflect the licensee's intent to begin fu and reclamation of the site leading to termination of the specific license. The mill was demolished and dispose tailings impoundment in late 2003. The demolition was completed in accordance with a mill demolition plan a NRC in October 2003. The staff issued a license amendment for alternate concentration limits (ACLs) at the si 2006. Consequently, all groundwater corrective actions have been discontinued, and Rio Algom is finalizing th reclamation. *A portion of the tailings impoundment is still open for disposal of Atomic Energy Act, Section 11e* material. A final soil DP entitled, Closure Plan - Lined Evaporation Ponds (Relocation Plan) was submitted to th November of 2004, and partially approved. A portion of the report, pertinent to the "Section 4" and Pond 9 ev pond sediment material is still under review. It is estimated that that portion of the review will be completed l 2007. The cost for decommissioning is estimated to be approximately $18 million.

3.0 Major Technical or Regulatory Issues

Rio Algom has notified NRC that they intend to sell the property and that the license will be transferred.

4.0 Estimated Date For Closure

01/01/2010

Tuesday, December 04, 2007

Ambrosia Lake, New Mexico, Disposal Site

FACT SHEET

This fact sheet provides information about the Uranium Mill Tailings Radiation Control Act of 1978 Title I disposal site located at Ambrosia Lake, New Mexico. The site is managed by the U.S. Department of Energy Office of Legacy Management.

Site Description and History

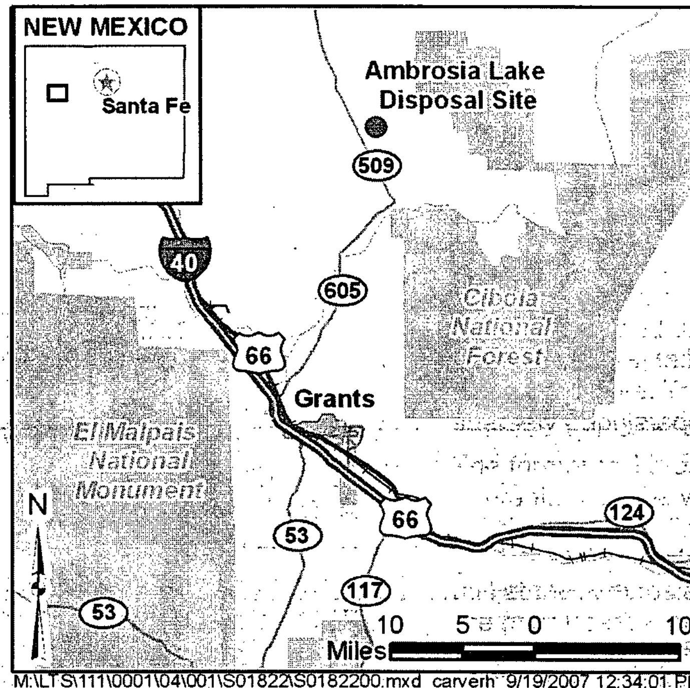
The Ambrosia Lake Disposal Site is a former uranium ore processing facility in McKinley County, approximately 25 miles north of Grants, New Mexico. The site is in the Ambrosia Lake Valley, a broad, elongate valley dominated by desert grassland plant communities and basalt-capped mesas to the north. The site is within the Ambrosia Lake Mining District, near the center of the Grants Mineral Belt. Decommissioned uranium mills, abandoned underground mines, mine shafts and vents, ore piles, tailings piles, and heap leach piles are close to the site. The area surrounding the millsite is sparsely populated.

The former mill processed more than 3 million tons of uranium ore between 1958 and 1963 and provided uranium for U.S. Government national defense programs. Phillips Petroleum Company built the original mill at the Ambrosia Lake site in 1957 to process ore from nearby mines. United Nuclear Corporation purchased and operated the mill for a brief period in 1963, then ceased milling operations but retained ownership of the site. In the late 1970s to early 1980s, United Nuclear Corporation operated an ion exchange system, extracting uranium from mine water. All mill operations ceased in 1982, leaving radioactive mill tailings, a predominantly sandy material, on approximately 111 acres. Wind and water erosion spread some of the tailings across a 230-acre area.

The U.S. Department of Energy (DOE) remediated the Ambrosia Lake site and local contaminated vicinity properties between 1987 and 1995. Surface remediation consisted of consolidating and encapsulating all contaminated material on site in an engineered disposal cell. The disposal cell occupies 91 acres of a 290-acre tract of land.

Regulatory Setting

Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) in 1978 (Public Law 95-604), which required the cleanup of 24 inactive uranium ore-processing sites. DOE remediated these sites under the Uranium Mill Tailings Remedial Action Project in accordance with standards promulgated by the U.S. Environmental Protection Agency in Title 40 *Code of Federal Regulations* (CFR) Part 192. Subpart B of 40 CFR 192 regulated cleanup of contaminated ground water at the processing sites. The radioactive materials were encapsulated in U.S. Nuclear Regulatory Commission-approved disposal cells. The U.S. Nuclear Regulatory Commission general license for UMTRCA Title I sites is established in 10 CFR 40.27. The Ambrosia Lake Disposal Site was included under the general license in 1998.

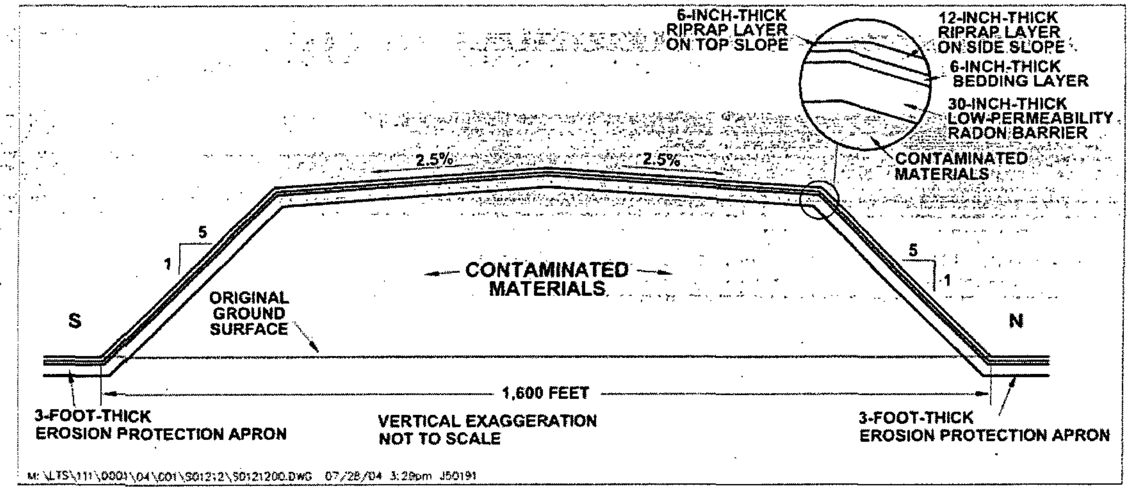


Location of the Ambrosia Lake Disposal Site

Disposal Site

The disposal cell was closed in 1995 upon encapsulation of the tailings and completion of the cell cover. The cell contains 6.9 million dry tons (about 5.2 million cubic yards) of contaminated material, with a total activity of 1,850 curies of radium-226.

The uppermost aquifer beneath the site consists of alluvium (river deposits), sandstone, and weathered shale. The maximum thickness of the aquifer is approximately 175 feet; the maximum saturated thickness is 25 feet. This uppermost aquifer is not a current or potential source of drinking water because of low yield.



South-North Cross Section of the Ambrosia Lake Disposal Site

Compliance Strategy

The ground water compliance strategy for the Ambrosia Lake Disposal Site is no remediation and the application of supplemental standards. The strategy of supplemental standards may be applied at UMTRCA sites where ground water in the uppermost aquifer is classified as limited use because it meets any of several criteria. Ground water at the Ambrosia Lake site meets the criterion of low yield, that is, the quantity of water reasonably available for sustained continuous use is less than 150 gallons per day (40 CFR 192.11[e]). Past milling operations, such as wastewater disposal and seepage from the tailings pile, supplied most of the water that recharged the aquifer. Those sources no longer exist, and the tailings and other contaminated materials are encapsulated in an engineered disposal cell. The alluvium is expected to return to the conditions of little to no saturation that prevailed before milling and mining began in the area. Because ground water is not a present or potential resource, no monitoring is required at the site. However, at the request of the New Mexico Environment Department, DOE samples two monitor wells every 3 years to monitor cell performance.

Disposal Cell Design

The rectangular disposal cell measures approximately 2,500 feet by 1,600 feet, including the toe apron. The cell rises approximately 50 feet above the surrounding terrain.

The cover of the Ambrosia Lake disposal cell is a multicomponent system designed to encapsulate and protect the contaminated materials. The disposal cell cover comprises (1) a low-permeability radon barrier (first layer placed over compacted tailings) consisting of compacted clayey soil, (2) a bedding layer of granular bedding material, and (3) a rock (riprap) erosion-protection layer for the top and side slopes.

A rock apron of larger diameter riprap surrounds the toe of the disposal cell. The ground immediately adjacent to the cell perimeter has been graded away from the cell to protect the site from storm water runoff. Disturbed areas have been successfully revegetated.

Legacy Management Activities

DOE manages the disposal site according to a site-specific Long-Term Surveillance Plan to ensure that the disposal cell systems continue to prevent release of contaminants to the environment. Under provisions of this plan, DOE conducts annual inspections of the site to evaluate the condition of surface features, performs site maintenance as necessary, and samples two monitor wells every 3 years. The encapsulated materials will remain potentially hazardous for thousands of years.

In accordance with 40 CFR 192.32, the disposal cell is designed to be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. However, the general license has no expiration date, and DOE's responsibility for the safety and integrity of the Ambrosia Lake Disposal Site will last indefinitely.

Contacts

Site-specific documents related to the Ambrosia Lake Disposal Site are available on the DOE Office of Legacy Management website at http://www.LM.doe.gov/land/sites/nm/amb/amb.htm.

For more information about the DOE Office of Legacy Management activities at the Ambrosia Lake Disposal Site, contact

U.S. Department of Energy
Office of Legacy Management
2597 B¾ Road, Grand Junction, CO 81503

(970) 248-6070 (monitored continuously), or
(877) 695-5322 (toll-free)

REFERENCES

33-36

Evaluation of Impacts from Section 35 and 36 Mine Dewatering

Ambrosia Lake Valley, New Mexico

Prepared by:

INTERA Incorporated
6000 Uptown Blvd., Ste 100
Albuquerque, New Mexico 87110

Submitted To:

Rio Algom Mining, LLC
5 Miles North of Hwy 509 & Hwy 605 Intersection
Ambrosia Lake Valley, New Mexico 87020

October 26, 2007

1.0 INTRODUCTION

This *Evaluation of Impacts from Section 35 and 36 Mine Dewatering* (Report), prepared by INTERA Incorporated (INTERA), is being submitted pursuant to two letters from the New Mexico Environment Department (NMED) dated May 17, 2005 (NMED, 2005) and December 14, 2006 (NMED, 2006b). These letters require compliance with 20.6.2.1203 New Mexico Administrative Code (NMAC) for reporting of soil contamination related to mine dewatering activities at the Rio Algom Mining Company's (Rio Algom's) Section 35 and 36 mines along the eastern edge of Ambrosia Lake Valley (the Site) and require appropriate corrective action to address impacts resulting from unpermitted discharges. The field investigations described in this Report were completed in accordance with the Rio Algom corrective action work plan dated September 29, 2006 (Appendix A) and a conditional approval letter from the NMED dated December 14, 2006 (NMED, 2006b).

2.0 HISTORICAL OPERATIONS-RELEVANT BACKGROUND

In a letter to the NMED dated April 12, 2005 (Rio Algom, 2005), Rio Algom reported that dewatering activities associated with the Section 35 and 36 mines had affected the land surface. The Section 35 and 36 mines were continuously dewatered for the removal of ore from 1957 to 1990 and large volumes of water were discharged to the land surface, resulting in the accumulation of radionuclides in the soil.

The dewatering activities, which ceased in 1990, were originally regulated under a federal National Pollutant Discharge Elimination System (NPDES) permit (NM 0028118); however, from September 1976 until August 1978, and thereafter starting in 1980, the activities were regulated under NMED discharge permit (DP) 67. Prior to construction of the Section 35 ponds association with the IX mine water treatment facility, which became operational in 1976 under a permit from the New Mexico Radiation Protection Bureau, discharges from the two mines were separate, largely untreated, and was discharged directly into the natural drainage. Groundwater pumped to dewater the Section 35 Mine was discharged to settling ponds near the mine shaft and then allowed to discharge following the natural drainage pattern to the south and southwest. The rate of this discharge after mining began in late 1970 was approximately 370 gallons per minute (gpm) in 1971, approximately 500 gpm in 1972, and averaged between 900 and 1,000 gpm from 1973 through 1977. From 1960 to 1984, the groundwater discharged from the adjacent Section 36 Mine was first ponded near the shaft and then diverted through an incised arroyo to an area in the southwest corner of Section 35 for settling prior to overflow. The water was then released into the natural drainage pattern across the contiguous T13N R9W Section 2. The average discharge rate from the Section 36 Mine was 1,400 gpm between 1960 and 1977. The discharged water was collected for stock watering in ditches, diverted for irrigation use by local ranchers, lost to evapotranspiration processes, or infiltrated alluvial sediments, particularly in areas subject to natural or manmade ponding.

By 1978, as both surface water and groundwater discharges came under additional regulatory scrutiny, plans for more efficient management of the mine water discharge were implemented by maximizing its distribution and conveyance off-site for beneficial use in irrigation. This new water management strategy was initiated in part as a result of an assertion by the U.S. Environmental Protection Agency (EPA) that the discharge should be regulated under an NPDES permit. Kerr-McGee disputed EPA's determination, but nonetheless undertook controlled spreading and irrigation which resulted in EPA terminating the NPDES permit. The water management strategy involved greater spreading of the discharge through enhanced distribution to guide the treated mine water runoff into areas outside of, but adjacent to, natural drainage channels or watercourses. This was accomplished through a system of distribution ditches and diversionary structures that accounted for the local topography.

By 1984, the Section 36 Mine closed and discharges ceased. After acquiring the site from Kerr-McGee in 1989, Rio Algom also closed the Section 35 IX facility and in early 1990 started piping Section 35 water to the Rio Algom Mill. At this time, all further surface discharges and irrigation uses of the water ceased.

3.0 REGULATORY SETTING

In 1979-80, Kerr-McGee obtained a groundwater discharge permit, DP-67, for the Section 35 and 36 mines, covering the IX treatment facility, the associated pond facilities, and the final outfall. The permit was thereafter renewed every five years and was an active discharge permit through June 2002. At this time, DP-67 remains in a 'stand-by' active status pending application for renewal and/or completion of drainage area corrective actions which are the subject of this Report.

In 2005, on the basis of an internal review, Rio Algom determined there likely was contamination of the mine sites and adjacent lands by virtue of the dewatering and historical discharge practices of Kerr-McGee at the Section 35 and 36 mines. Rio Algom conducted a gamma radiation field survey of the area to preliminarily assess probable lateral extent of radiological contamination in surface soils associated with the Section 35 and Section 36 mines discharge. As a result of the preliminary assessment, Rio Algom determined it was necessary to report it's findings, and did so by letter dated April 12, 2005 (Rio Algom, 2005).

NMED treated the preliminary assessment as a notification under Section 20.6.3.1203, which mandates Rio Algom to take prescribed steps and appropriate corrective action in response to the discharge. Since discharges after 1979 were regulated under the discharge permit, NMED's phase (Phase 1) from May through July 2005 and reported its findings to the NMED in *Characterization Report for the Section 35 and 36 Mine Drainage* (ERG, 2005).

ERG performed the following tasks for the Phase 2 investigation:

- Soil samples were collected up to 12 feet bgs, using a Geoprobe®.
- A global positioning system-based gamma survey was conducted in a previously uncharacterized area.

Details of this investigation are provided in Appendix B. Key observations and conclusions from this work are summarized as follows:

- The range of radionuclide concentrations in all samples was 0.2 to 18 pCi/g with the average radium-226 concentrations decreasing with increasing depth: 5.4 pCi/g (0-1 feet), 2.2 pCi/g (1-2 feet), 0.9 pCi/g (2-4 feet), 2.9 pCi/g (4-6 feet), and 0.3 pCi/g (10-12 feet).
- Radium-226 concentrations exceed assumed background concentrations at their respective depths in 69 of the 78 samples.
- Average uranium concentrations also decrease with depth in the soil layers: 11.59 milligrams per kilogram (mg/kg) (0-1 feet), 16.10 mg/kg (1-2 feet), 11.79 mg/kg (2-4 feet), 8.99 mg/kg (4-6 feet), and 2.50 mg/kg (10-12 feet).
- Uranium concentrations exceed assumed background concentrations at their respective depths in 77 of the 78 samples. The leachable fraction of uranium exceeds the New Mexico Water Quality Control Commission (WQCC) standard in several samples, predominantly at 1 to 6 feet bgs, but not at 10 to 12 feet bgs.
- Trends in the average ratios of leachable to total concentrations indicate that the leachable fractions of radium and uranium in the soils are essentially constant with depth. The leachable fraction of selenium increases with depth, but the dissolved leachable concentrations are below the WQCC standard at 10-12 feet bgs and total concentrations are below the NMED Soil Screening Levels (SSL) in all soil samples.
- With the exception of arsenic, total metals concentrations were below the NMED SSL in all Phase 2 soil samples; ERG notes that background level for arsenic may be higher than the SSL.
- With the exception of selenium, leachable metals concentrations were below respective WQCC standards in all Phase 2 soil sample results.

- The concentrations of leachable major ions (nitrate/nitrite, chloride, and sulfate) and TDS are below their respective NMWQCC standards in all soil samples.
- Radium-226 concentrations in the soil samples indicate no significant changes in the soil removal volume estimates presented in the 2005 characterization report (ERG, 2005).
- The Phase 2 gamma survey revealed new areas where the radium-226 concentrations are likely to exceed Uranium Mill Tailings Radiation Control Act standards, adding an estimated 2.1 percent to the best volume estimate provided in the 2005 characterization report (ERG, 2005).

6.0 GROUNDWATER SAMPLING

This section summarizes the groundwater sampling field activities conducted by Rio Algom and INTERA staff during May 2007 and September 2007. The samples taken by Rio Algom staff in May 2007 were obtained during well purging activities and were considered screening-level samples as the wells were not yet stabilized. The September 2007 field sampling completed by INTERA and Rio Algom staff was conducted according to procedures described in the U.S. Geological Survey Book 9, *Techniques of Water-Resource Investigations, and National Field Manual for the Collection of Water Quality Data*, Chapter A4. Collection of Water Samples, Revised 2006 (USGS, 2006).

Site-specific health and safety training was conducted for INTERA personnel by Rio Algom management and on-site tailgate safety meetings were held by INTERA each day in accordance with Rio Algom's site-specific Summary Health and Safety Plan, dated September 7, 2007 (Appendix C).

Field notes were recorded in a dedicated, bound field notebook and are provided as Appendix D. Water Purging and Sampling Data Forms were used to record well specifications, field parameters, and related sampling notes and are provided as Appendix E. The sampling was conducted in general accordance with the work plan developed by Rio Algom (Appendix A). Well diagrams sketched in the field notebook were based on the assumption that each well contained a 10-foot screen that spanned the distance from the well's total depth to 10 feet above total depth. INTERA has since learned that the actual screen length is 20 feet.

6.1. Field Investigation Activities and Results

6.1.1. Field Equipment

The field equipment and supplies used to conduct the water sampling are listed below.

Though some constituents in the groundwater at this Site do exceed WQCC standards, we do not believe there is a threat to human health or the environment for the following reasons:

- As demonstrated in ERG's Phase I and Phase 2 Characterization Reports, radionuclides and metals attributable to impacts from mine dewatering operations are being effectively attenuated in the upper few feet of the alluvial sediments.

- The source for the groundwater present in the alluvium is the mine dewatering activities which have been terminated since 1984. The supporting evidence for this water source is the low yield, turbid character, and poor water quality of the alluvial groundwater.

- ~~The alluvial groundwater in the vicinity of the Section 4~~ ponds is from the same mine-dewatering source. Investigation activities in this area have definitively shown that water levels are dropping and the shallow alluvial groundwater is drying up, thus groundwater will not migrate very far.

- The water levels measured in these monitoring wells indicate a groundwater flow direction to the south. A search of the Office of the State Engineer records for domestic wells in the area revealed only three down-gradient wells, all of which are screened between 300 and 500 feet bgs (Table 4). (The fact that the only wells in the area are drilled to depths of 300 feet or greater further indicates that the alluvium was not a groundwater source). Thus, there are no groundwater receptors in the area that could be impacted by the Section 35 and 36 mine discharges.

- Radium is not present in groundwater and is being attenuated effectively in the shallow alluvial sediments.

- Uranium and selenium exceed WQCC standards in some samples; however, it has been demonstrated that natural attenuation will reduce the concentration of these constituents in groundwater.

- Although more mobile constituents of concern such as sulfate and TDS exceed WQCC standards in the groundwater samples, there are no water supply wells in the alluvium in this area, and it has been demonstrated that the alluvial groundwater will dissipate with time now that mine dewatering activities have ceased.

- Nitrate concentrations are in excess of the WQCC standards, however, this constituent was not present at significant concentrations in the mine water discharge and it is likely that concentrated cattle grazing in this area of water and heavy vegetation is responsible for these elevated nitrate concentrations.

(10)

United States Nuclear Regulatory Commission
Office of Public Affairs
Washington, DC 20555
Phone 301-415-8200 Fax 301-415-2234
Internet:opa@nrc.gov

No. 97-146

FOR IMMEDIATE RELEASE
(Friday, October 3, 1997)

NRC TRANSFERS RESPONSIBILITY FOR NEW MEXICO URANIUM MILL TAILINGS DISPOSAL SITE TO DOE

The Nuclear Regulatory Commission has granted the request of Atlantic Richfield Company (ARCO) to terminate its license for a uranium mill site near Grants, New Mexico, and has placed the site under the custody and long-term care of the Department of Energy, which is now the licensee for the site.

The tailings represent a long-term potential health hazard to public health and safety because they contain radium, which generates radon gas. Therefore the NRC requires that the tailings be stabilized and covered with a clay barrier that prevents release of the gas.

The ARCO mill began operation in 1953 and operated until 1982. During that period, approximately 24 million tons of uranium mill tailings were produced as a byproduct of the uranium milling.

The Uranium Mill Tailings Radiation Control Act of 1978 requires cleanup of soil contamination, long-term stabilization and control of tailings, and cleanup of groundwater at uranium mill sites. Before terminating the ARCO license, the NRC verified that the Bluewater site had been cleaned up in accordance with applicable standards and that stabilization of the tailings was in accordance with regulations and a previously approved design. The NRC also reviewed DOE's plan for long-term care of the site and concluded that the plan satisfied the requirements of the Act.

The ARCO mill site is the second commercially operated uranium mill to be cleaned up satisfactorily in conformance with NRC requirements. ARCO transferred $635,165 to DOE to cover the costs of annual inspections to ensure that the site is maintained.

Any person whose interest may be affected by the licensing action may file a request for a hearing. The request should be filed within 30 days after the publication of a Federal Register notice on this subject, which is expected shortly. Procedures for filing the request will be described in the Federal Register notice.

###

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 22, 1996

RECEIVED

MAY 17

Mr. R. S. Ziegler, Project Manager
Atlantic Richfield Company
Bluewater Mill
P.O. Box 638
Grants, New Mexico 87020

SUBJECT: APPROVAL OF GROUNDWATER ALTERNATE CONCENTRATION LIMITS, AMENDMENT 30 TO SOURCE MATERIAL LICENSE SUA-1470

Dear Mr. Ziegler:

By letters dated June 20, 1990 and August 27, 1991, Atlantic Richfield Company (ARCO) requested amendment of Source Material License SUA-1470 to approve groundwater alternate concentration limits (ACLs) for the Bluewater Uranium Mill near Grants, New Mexico. The staff requested additional information by letter dated January 20, 1995, and met with ARCO on February 9, 1995, to discuss the NRC's comments. Information in response to the NRC's letter and the subsequent meeting was submitted by ARCO on April 25, 1995. The NRC staff has reviewed this information and has concluded that the ACLs proposed in the April 25, 1995, submittal are acceptable.

Therefore, pursuant to Title 10 of the Code of Federal Regulations (10 CFR), Part 40 Source Material License SUA-1470 is hereby amended by modifying License Condition No. 34 to incorporate the ACLs based on the staff's Technical Evaluation Report for the license amendment (Enclosure 1). LC No. 34.C has been revised to require ARCO to propose a new corrective action program in the event the ACLs are exceeded in the future. Since the revised concentration limits in 34.B (the ACLs) have been met, no further corrective action is required at this time.

The license is being reissued to incorporate the above modifications (Enclosure 2). These changes to the license were discussed and agreed to via telecon between Ken Hooks of the NRC and Nat Patel of ARCO. All other conditions of the license shall remain the same. An environmental review was not performed, since this action is categorically excluded under 10 CFR 51.22(c)(11), and an environmental report from the licensee is not required by 10 CFR 51.60(b)(2).

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U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE

2

...ant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of ...al Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Atlantic Richfield Company [Applicable Amendments: 7, 14]	3. License Number SUA-1470, Amend. No. 30
2. Bluewater Mill P. O. Box 638 Grants, New Mexico 87020 [Applicable Amendments: 2, 7, 14]	4. Expiration Date Until NRC determines ~~reclamation is adequate~~
	5. Docket or Reference No. ~~40-8902~~

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
Uranium Byproducts	Any	Unlimited

9. Authorized place of use: The licensee's uranium milling facilities located near Grants, New Mexico.

10. The licensee is hereby authorized to possess byproduct material in the form of uranium waste tailings and other byproduct wastes generated by the licensee's past milling operations. The licensee is not authorized to produce uranium concentrate without a license amendment approved by the NRC. [Applicable Amendment: 25]

11. DELETED by Amendment 27.

12. The results of all effluent and environmental monitoring required by this license shall be reported in accordance with 10 CFR 40, Section 40.65 with copies of the report sent to the NRC. Monitoring data shall be reported in the format shown in Regulatory Guide 4.14 and enclosed as the attachment to SUA-1470 entitled, "Sample Format for Reporting Monitoring Data." [Applicable Amendment: 25]

13. Before engaging in any activity not previously assessed by the NRC, the licensee shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not previously assessed or that is greater than that previously assessed, the licensee shall provide a written evaluation of such activities and obtain prior approval of the NRC in the form of a license amendment.

14. Prior to termination of this license, the licensee shall provide for transfer of title to byproduct material and land, including any interests therein (other than land owned by the United States or the State of New Mexico), which is used for the disposal of such byproduct material or is essential to ensure the long term stability of such disposal site to the United States or the State of New Mexico, at the State's option.

ARCO's currently approved surety instrument, Performance Bond No. U-8001407, issued by the Reliance Insurance Company and United Pacific Insurance Company in favor of the NRC, shall be continuously maintained in an amount no less than $3,500,000 for the purposes of complying with 10 CFR 40, Appendix A, Criteria 9 and 10, until a replacement is authorized by the NRC. [Applicable Amendments: 11, 14, 17, 21, 25, 29]

26. Operation of evaporation ponds 1-A, 1-B, 2-A, 2-B, 3-A, 3-B and 3-C is authorized in accordance with submittals dated July 18, 1977 and September 29, 1977 for ponds 1-A and 1-B; August 1, 1978 for ponds 2A and 2B; and April 10, 1980 and May 2, 1980 for ponds 3A, 3B, and 3C.

27. DELETED by Amendment No. 27.

28. DELETED by Amendment No. 3.

29. DELETED by Amendment No. 3.

30. The licensee shall conduct an inspection of the tailings impoundment area using trained personnel at least once every 24 hours, excluding weekends and holidays.

31. The licensee shall decommission the Bluewater Uranium Mill in accordance with the decommissioning plan submitted by letter dated December 29, 1987, as revised by submittals dated August 9, September 26, and November 17, 1988; February 27 and June 16, 1989; March 6, 1990; and January 19, 1994. [Applicable Amendments: 8, 10, 15, 23]

32. The licensee shall implement the radiation safety and environmental monitoring programs specified in its letters dated February 20, 1995 and February 22, 1995. Notwithstanding the groundwater monitoring specified in Attachment 39 and revisions thereof, the licensee shall perform the compliance monitoring described in License Condition No. 34. Whenever the word "will" is used in the documents referenced above, it shall denote a requirement.

[Applicable Amendments: 3, 25, 27]

33. The licensee shall conduct an annual survey of land use (grazing, residence, wells, etc.) in the area within two miles of the mill and submit a report of this survey annually to the NRC. This report shall indicate any differences in land use from that described in the licensee's previous annual report. The report shall be submitted by July 1 of each year. [Applicable Amendments: 3, 25]

34. The licensee shall implement a groundwater compliance monitoring program containing the following:

A. Sample on a semiannual frequency, wells E(M), T(M) and F(M) for molybdenum, natural uranium and selenium, and wells S(SG), L(SG) and OBS#3 for natural uranium and selenium.

B. Comply with the following Alluvial aquifer groundwater protection standards (alternate concentration limits proposed in licensee submittal dated July 25, 1995) at point of compliance wells T(M) and F(M), with background being recognized in well E(M):

molybdenum = 0.10 mg/l, U-nat = 0.44 mg/l (300 pCi/l) and selenium = 0.05 mg/l.

Comply with the following San Andres aquifer groundwater protection standards (alternate concentration limits proposed in licensee submittal dated July 25, 1995) at point of compliance wells OBS#3 and S(SG), with background being recognized in well L(SG):

selenium = 0.05 mg/l and U-nat = 2.15 mg/l

C. In the event the limits in Subsection (B) are exceeded, the licensee will propose a new corrective action program with the objective of returning concentrations of molybdenum, U-nat and selenium to the concentration limits specified in Subsection (B).

The licensee shall, on a semiannual frequency, submit a groundwater monitoring report as well as submit a corrective action program review, by December 31 of each year, that describes the progress towards attaining groundwater protection standards.

[Applicable Amendments: 4, 6, 7, 20, 30]

35. The licensee is authorized to dispose of byproduct waste from the Tucson Research Center in accordance with the submittal dated, August 24, 1989. In addition, the licensee shall comply with the following:

A. Solid waste shall be disposed in trenches constructed in the main tailings pile. The licensee shall take steps to minimize void space in the disposed material.

B. Empty drums shall be disposed in accordance with the decommissioning plan specified in Condition No. 31 of this license.

C. All waste disposal shall be documented. [Applicable Amendment: 9]

36. The licensee shall reclaim the tailings disposal area as stated in its March 21, 1990, reclamation plan as revised by submittals dated July 12, July 19, July 23, August 2, and August 8, 1990; November 25, 1991, with the exception of Section 7.0, December 22, 1993, and July 28 and August 31, 1994; and March 6 and May 15, 1995. In addition, the licensee shall:

A. Construct the radon barrier for the main tailings pile to minimum average thicknesses of 73 cm. for the sands area, 30.5 cm. for the mixed tailings area, and 73 cm. for contaminated outslopes. The radon barrier will be a minimum thickness of 15 cm. for the slimes area.

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B. Submit for NRC review and approval the correlation of nuclear

U.S. ENVIRONMENTAL PROTECTION AGENCY

Superfund Information Systems

Superfund Site Information

BROWN VANDEVER MINE

Site Information

Site Info | Aliases | Operable Units | Contacts
Actions | Contaminants | Site-Specific Documents

This site has been archived from the inventory of active sites.

Site Name: BROWN VANDEVER MINE
Street: 4 MILES EAST OF PREWITT
City / State / ZIP: PREWITT, NM 87045

NPL Status: Not on the NPL
Non-NPL Status: NFRAP

EPA ID: NND986669117
EPA Region: 09
County: MCKINLEY

Federal Facility Flag: Not a Federal Facility

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BROWN VANDEVER MINE

Actions

Site Info | Aliases | Operable Units | Contacts
Actions | Contaminants | Site-Specific Documents

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	DISCOVERY		F		03/01/1990
00	PRELIMINARY ASSESSMENT	H	F		07/17/1990
00	ARCHIVE SITE		EP		12/10/1992
00	SITE INSPECTION	N	S		12/10/1992

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ANACONDA CO BLUEWATER URANIUM MILL

Site Information

Site Info | Aliases | Operable Units | Contacts
Actions | Contaminants | Site-Specific Documents

This site has been archived from the inventory of active sites.

Site Name: ANACONDA CO BLUEWATER URANIUM MILL
Street: T12N R11W
City / State / ZIP: GRANTS, NM 87020

NPL Status: Not on the NPL
Non-NPL Status: NFRAP

EPA ID: NMD007106891
EPA Region: 06
County: CIBOLA

Federal Facility Flag: Not a Federal Facility

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ANACONDA CO BLUEWATER URANIUM MILL

Actions

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Actions | Contaminants | Site-Specific Documents

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	DISCOVERY		F		01/01/1980
00	ARCHIVE SITE		EP		04/01/1980
00	PRELIMINARY ASSESSMENT	N	F	04/01/1980	04/01/1980

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Superfund Site Information

HAYSTACK BUITE MINING DISTRICT

Site Information

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Actions | Contaminants | Site-Specific Documents

This site has been archived from the inventory of active sites.

Site Name: HAYSTACK BUITE MINING DISTRICT
Street: 12 MI N GRANTS,6 MI S AMBROSIA
City / State / ZIP: MILAN, NM 87005

NPL Status: Not on the NPL
Non-NPL Status: NFRAP

EPA ID: NMD980878771
EPA Region: 06
County: CIBOLA

Federal Facility Flag: Not a Federal Facility

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HAYSTACK BUITE MINING DISTRICT

Actions

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Actions | Contaminants | Site-Specific Documents

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	DISCOVERY		F		09/01/1984
00	PRELIMINARY ASSESSMENT	L	S	11/01/1984	11/01/1984
00	ARCHIVE SITE		EP		12/01/1985
00	SITE INSPECTION	N	S	12/01/1985	12/01/1985

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KERR-MCGEE NUCLEAR CORP

Site Information

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Actions | Contaminants | Site-Specific Documents

This site has been archived from the inventory of active sites.

Site Name: KERR-MCGEE NUCLEAR CORP
Street: AMBROSIA LAKE
City / State / ZIP: GRANTS, NM 87020

NPL Status: Not on the NPL
Non-NPL Status: NFRAP

EPA ID: NMD005570015
EPA Region: 06
County: CIBOLA

Federal Facility Flag: Not a Federal Facility
Incident Category: Other

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KERR-MCGEE NUCLEAR CORP

Actions

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Actions | Contaminants | Site-Specific Documents

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	DISCOVERY		F		02/01/1980
00	ARCHIVE SITE		EP		02/01/1981
00	PRELIMINARY ASSESSMENT	N	F	02/01/1981	02/01/1981

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MT TAYLOR URANIUM MINE

Site Information

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Actions | Contaminants | Site-Specific Documents

This site has been archived from the inventory of active sites.

Site Name: MT TAYLOR URANIUM MINE
Street: SR334,1.0 MIS NE OF CITY
City / State / ZIP: SAN MATEO, NM 87050

NPL Status: Not on the NPL
Non-NPL Status: NFRAP

EPA ID: NMD000778605
EPA Region: 06
County: CIBOLA

Federal Facility Flag: Not a Federal Facility

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Superfund Site Information

MT TAYLOR URANIUM MINE

Actions

Site Info | Aliases | Operable Units | Contacts
Actions | Contaminants | Site-Specific Documents

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	PRELIMINARY ASSESSMENT	L	F	04/01/1981	04/01/1981
00	DISCOVERY		F		05/01/1981
00	SITE INSPECTION	N	S	04/01/1986	04/01/1986
00	ARCHIVE SITE		EP		09/26/1994

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POISON CANYON MINING DISTRICT

Site Information

This site has been archived from the inventory of active sites.

Site Name: POISON CANYON MINING DISTRICT
Street: 10.5MI N JNCT ST RTE 53 & US66
City / State / ZIP: MILAN, NM 87021

NPL Status: Not on the NPL
Non-NPL Status: NFRAP

EPA ID: NMD981600489
EPA Region: 06
County: CIBOLA

Federal Facility Flag: Not a Federal Facility

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U.S. ENVIRONMENTAL PROTECTION AGENCY

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POISON CANYON MINING DISTRICT

Actions

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	DISCOVERY		S		12/01/1986
00	PRELIMINARY ASSESSMENT	N	S	08/01/1987	08/01/1987
00	ARCHIVE SITE		EP		10/01/1989
00	SITE INSPECTION	N	F	10/01/1989	10/01/1989

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UNC SAN MATEO MINE

Site Information

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Actions | Contaminants | Site-Specific Documents

This site has been archived from the inventory of active sites.

Site Name: UNC SAN MATEO MINE
Street: 2 1/2 MI.SE OF SR53
City / State / ZIP: SAN MATEO, NM 87050

NPL Status: Not on the NPL
Non-NPL Status: Deferred to RCRA

EPA ID: NM1223075515
EPA Region: 06
County: CIBOLA

Federal Facility Flag: Federal Facility
Incident Category: Mines/Tailings

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UNC SAN MATEO MINE

Actions

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	DISCOVERY		S		06/30/1988
00	PRELIMINARY ASSESSMENT	D	FF		01/20/1989
00	ARCHIVE SITE		EP		12/07/1995
00	SITE INSPECTION	D	S		12/07/1995

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Superfund Site Information

FEBCO URANIUM MINE

Site Information

Site Name: FEBCO URANIUM MINE
Street: NAVAJO NATION
City / State / ZIP: PREWITT, NM 87045

NPL Status: Not on the NPL
Non-NPL Status: NFRAP

EPA ID: NND986669166
EPA Region: 09
County: MCKINLEY

Federal Facility Flag: Not a Federal Facility
Incident Category: Mines/Tailings

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Superfund Site Information

FEBCO URANIUM MINE

Actions

OU	Action Name	Qualifier	Lead	Actual Start	Actual Completion
00	DISCOVERY		F		07/16/1991
00	PRELIMINARY ASSESSMENT	N	TR	04/30/2001	06/11/2001

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Cleanup Activities at HOMESTAKE MINING CO. (EPA ID: NMD007860935)

Back to the Profile for this Site

There are many stages of cleanup including site study, remedy selection, remedy design, remedy construction, and post-construction. Activities undertaken early in the cleanup process focus on understanding problems at the site while those taken later in the cleanup process focus on physically addressing those problems identified. This tab provides a detailed list of cleanup activities at this site. Sometimes, these cleanup activities are called "actions".

Activity	Leading Organization	Area of Site Addressed (OU)	Start Date	Completion Date
FIVE-YEAR REVIEW (see glossary)	EPA Fund-Financed	(01)	02/15/2006	09/26/2006
View Documentation [2.91MB]				
FIVE-YEAR REVIEW (see glossary)	EPA In-House	(01)	Not Available	09/27/2001
View Documentation [1.38MB]				
COMMUNITY INVOLVEMENT (see glossary)	EPA Fund-Financed	(01)	05/05/1987	12/21/1999
PRELIMINARY CLOSE-OUT REPORT PREPARED (see glossary)	EPA Fund-Financed	(01)	Not Available	09/23/1996
POTENTIALLY RESPONSIBLE PARTY REMEDIAL ACTION (see glossary)	Responsible Party	(01)	12/31/1992	12/14/1993
Technologies Used: Alternate Drinking Water, Permanent Replacement; Cap; Disposal; Engineering Control, Not Specified; Evaporation; Excavation; and Pump And Treat.				
COST RECOVERY NEGOTIATIONS (see glossary)	Federal Enforcement	SITEWIDE (00)	09/01/1992	09/30/1993
ADMINISTRATIVE RECORDS (see glossary)	Federal Enforcement	(01)	07/17/1989	10/01/1992
Outcome: Admin Record Compiled for a Remedial Event				
REMOVAL ASSESSMENT (see glossary)	EPA Fund-Financed	SITEWIDE (00)	06/18/1991	12/13/1991

REFERENCES

37-40

DOE/AL/62350-211
REV. 1

United States Department of Energy

LONG-TERM SURVEILLANCE PLAN FOR THE AMBROSIA LAKE, NEW MEXICO DISPOSAL SITE

July 1996

Uranium Mill Tailings Remedial Action Project

Southwestern Region Environmental Compliance and Protection Program

&

Abandoned Mine Lands Program

Future CERCLA Projects

2008

- Coronado – Pena Blanca, $1.6M
- Lincoln – High Rolls, $675k
- Tonto – Workman Creek, $1.5M
- Cibola – San Mateo, $800k

(8)

(1)

ABANDONED MINE INVENTORY PILOT PROJECT REPORT

Prepared by:

Dave Sitzler
Mining Engineer

Don Zoss
Mining Engineer

Bureau of Land Management

Albuquerque District Office

September 20, 1985

2

Executive Summary

This project was a pilot study to determine time and costs associated with the inventorying of abandoned uranium mines located on Federal surface over Federal minerals within the Grants Uranium Belt. The pilot project identified all mines present as having potential problems with physical and radiological hazards. Hazards identified were erosion of waste piles; livestock and wildlife having access to water ponded in waste areas; improper or no abandonment of mine openings and structures; and no reclamation evident on any site other than removal of buildings and equipment.

Options for this study would be as follows:

1. Continue the study as outlined in this study.

2. Continue the study, but at a higher or lower level of funding.

3. Discontinue the study.

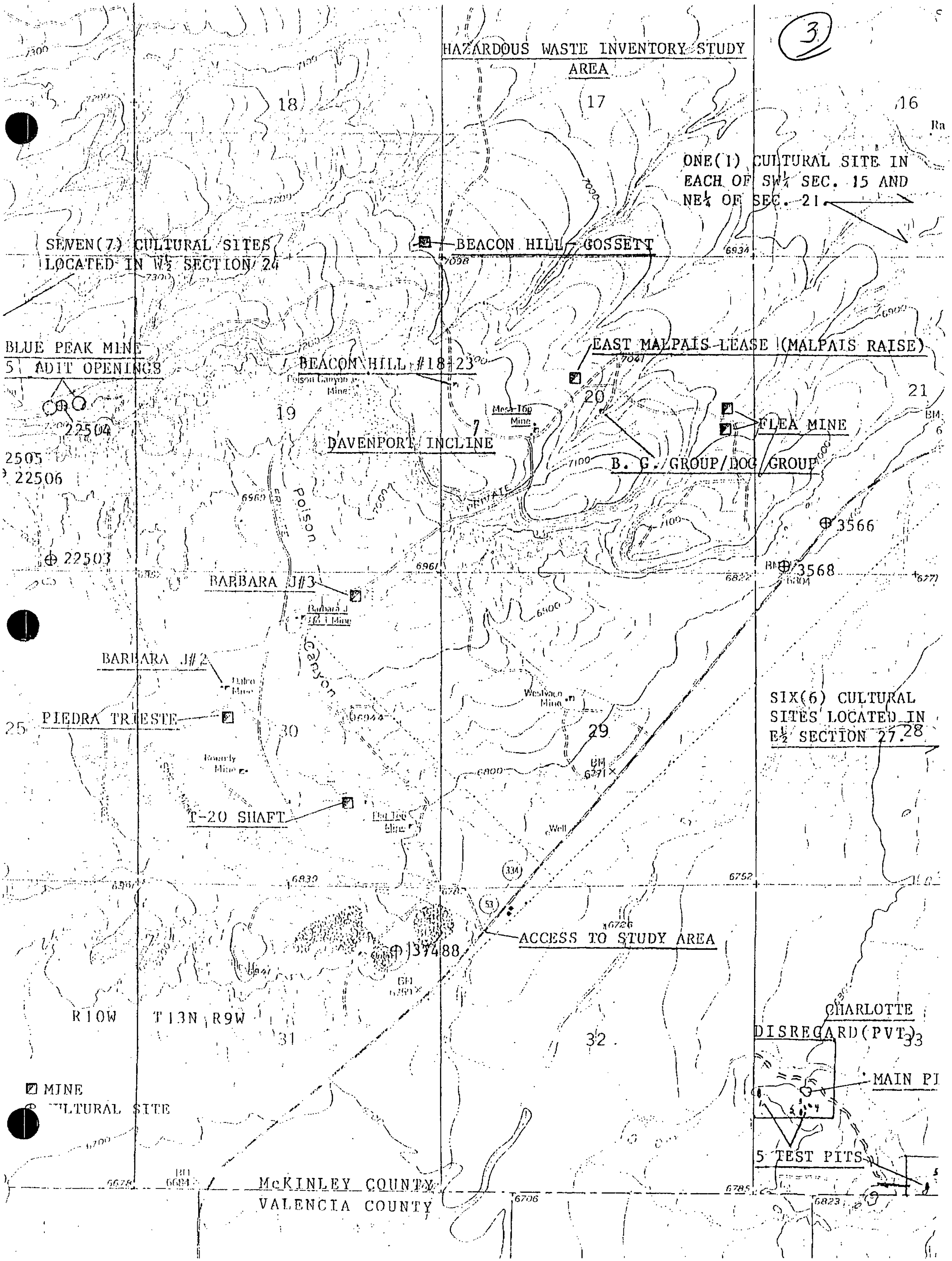
The District Office will propose a continuation of the study as outlined in the FY86 PAWP unless otherwise directed.

Introduction

The purpose of this pilot project is to determine time and costs associated with the inventorying of abandoned uranium mines located on Federal rface over Federal minerals within the Grants Uranium Belt. This inventory is needed to determine any mining hazards located on the public domain. Uranium mines were chosen to be inventoried first because they not only possessed physical safety problems due to open shafts, declines, vent holes, etc., but they also possess radialogical problems due to radon exhalation and emissions of gamma radiation. This inventory will also provide a compliance check of the reclamation required by the 3809 regulations for the post FLPMA mines.

Currently, the only requirements for reclamation of mines for locatable minerals on the public domain is contained within the 3809 regulations, and these cover only operations occurring after the passage of FLPMA in 1976. There are no reclamation requirements for pre-FLPMA mines and no requirements for the control of radiation from mines. Environmental laws like Resource Conservation and Recovery Act of 1976 and Comprehensive Environmental Response, Compensation and Liability Act of 1980 specifically exclude mine wastes.

The objective of this inventory is to identify any hazardous mine sites and take remedial acton. To reach this goal a three phase program is envisioned. Phase I, of which this pilot is part, is a physical inspection of the mine sites for potential physical safety and gamma radiation hazards. These sites will then be prioritized and Phase II begun. Phase II will involve detailed study of mine sites, including a radon exhalation survey, samples of any ponded water, detailed mapping, and possibly soil samples. ıse III will consist of remedial action of the hazards indentified in Phase . For post-FLPMA mines the operators will be required to do what work is necessary to satisfy the 3809 regulations. For pre-FLPMA mines that require remedial action, a management decision on how to proceed will be needed.



3
HAZARDOUS WASTE INVENTORY STUDY AREA
18
17
16
ONE(1) CULTURAL SITE IN EACH OF SW¼ SEC. 15 AND NE¼ OF SEC. 21.
SEVEN(7) CULTURAL SITES LOCATED IN W½ SECTION 24
BEACON HILL - GOSSETT
BLUE PEAK MINE
5 ADIT OPENINGS
BEACON HILL #18-23
Poison Canyon Mine
EAST MALPAIS LEASE (MALPAIS RAISE)
19
20
21
22504
2505
22506
Mesa Top Mine
DAVENPORT INCLINE
FLEA MINE
B. G. GROUP/DOG GROUP
PRIVATE
Poison
3566
22503
3568
BARBARA J#3
Barbara J
BARBARA J#2
Canyon
Westvaco Mine
SIX(6) CULTURAL SITES LOCATED IN E½ SECTION 27.
25
PIEDRA TRIESTE
30
29
28
Boundy Mine
T-20 SHAFT
Flat Top Mine
Well
334
53
ACCESS TO STUDY AREA
37488
R10W
T13N R9W
31
32
33
CHARLOTTE
DISREGARD(PVT)
MAIN PI
MINE
CULTURAL SITE
5 TEST PITS
McKINLEY COUNTY
VALENCIA COUNTY

(4)

showing the area's township, range and section lines. The mine locations and the areas of Federal surface and mineral ownership were shown. Other ownership and split estate ownership were left white. The maps were produced at the same scale as 7½ minute U.S.G.S. quadrangle maps to facilitate their use as overlays for the field inspection phase.

An inspection form was also developed that was to be filled out for each mine. The form was designed to be a narrative type report where each mine would be extensively described in several different catagories. Each form was to be a stand alone report of each site. This aspect was changed by the geologist doing the field inspections, to a checklist form supplemented with photos and limited narrative. During the rest of the project the original forms will be used. The field inspection consisted of visiting each site on the ground; filling out the form; taking photos; and taking random gamma radiation readings. This information was then compiled into a field report which is attached to this report.

Results of Pilot Project

Of the 23 mines initially identified to be inspected only 14 were inspected. The remaining nine were deleted since they had been mined from another mine (no surface disturbance) or they had been conveyed via patent from Federal control. All of the mines inspected have potential physical and radialogical hazards present. At the mines inspected seven shafts, nine declines, five adits, and seven ventilation holes were found. Most of these have been covered with steelplate, drill steel, or boards. However, none have been back filled and all can be entered with minimal effort. Subsidence has been identified at three of the mines, of which one subsidence feature has been identified as the cause of death of one cow.

Gamma radiation at the mines range from 6 microroentgens/hour (MR/hr) to 888 MR/hr with the "waste" piles and mine openings giving the highest readings. Though no standards exists for gamma radiation from mines, the Rio Puerco Resource Area has established guidelines for use on uranium mines on Indian lands. This guideline is based on the standards required by Nuclear Regulatory Commission ~~(10 CRF 209.105(a))~~ for uncontrolled access to reclaimed uranium mill tailings. The guideline calculates to 57 MR/hr above background. Background at the pilot area ranged from 9 to 12 MR/hr with an average of 10 MR/hr. This means that the reclamation standard would be 67 MR/hr or below. The gamma radiation present at the mines inspected range from 3 to 13 times the reclamation standards.

SHOULD BE 10 CFR PART 20.105 (a).

In most cases erosion is spreading waste material from the mine site. Of the 14 mines inspected only one was not being eroded, the other 13 were being eroded in one fashion or another (three of these mines are located in arroyos). It should be noted that this inspection did not identify excessive gamma radiation downstream from the eroding mine sites.

All mine sites have wild life in residence or signs of their transitory use. One mine has owls living in a decline. Four of the mines have evidence of transitory use by domesticated animals (sheep, goats and cattle). As noted above, a dead cow was found in a subsidence feature of one of the mines.

Only one of the mines in is proximity to an archaeological site.

ENVIRONMENTAL PROTECTION AGENCY
O‘ ‑ of Enforcement

REGION 6
First International [illegible] 1201 Elm St.
Dallas, Texas 75270

CHAIN OF CUSTODY RECORD

SITE ~~PROJ.~~ NO.	PROJECT NAME
408	Poison Canyon Mining District

SAMPLERS: *(Signature)* Carazon Halasan / Mike Sanders

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	ICAP SCAN (SOIL)	RADIONUCLIDES (SOIL)	AA (SOIL)				REMARKS
BJ#1	890713	1118	✓		BARBARA J #1 Mine	2	✓	✓	✓				
BJ#3A	"	1300	✓		" " #3 Mine	2	✓	✓	✓				
BJ#3B	"	1313	✓		" " #3 Mine dump	2	✓	✓	✓				
BJ#3C	"	1325	✓		" " #3 Mine	2	✓	✓	✓				
BG A	"	1505	✓		BACKGROUND A	2	✓	✓	✓				
BJ STREAM A													
	890713	155~~0~~			BJ STREAM A	2	✓	✓	✓				
STOCK POND	"	1615			STOCK POND BED	2	✓	✓	✓				
BG B	890714	0840			BACKGROUND B, SECT. 24	2	✓	✓	✓				

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Carazon Halasan Michael R Sanders	July 14, 1989 3:40 pm	Dianne Cass Radiochemistry Russell S Kessler AEHM			
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*

Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

6-14654

(2)

TABLE 1: POISON CANYON MINING DISTRICT
CHEMICAL DATA -- SOLIDS/INORGANICS
JULY 1989 SAMPLING

SAMPLE LOCATION	BETA/GAMMA EMISSIONS (ur/hr)	U-238	RADIONUCLIDES (pCi/g) U-234	Th-232	Th-230	Ra-226	Pb-210	HEAVY METALS (ug/g) Vanadium	Lead	Copper
BACKGROUND:										
Background A	24	5.53	6.80	0.50	6.86	6.30	6.60	6	<5	5
Background B	14	4.24	4.43	0.81	4.88	4.50	2.20	6	7	8
BJ #3A	15 - 20	1.29	1.22	0.40	3.23	3.92	2.00	12	6	9
STREAM/POND SEDIMENTS:										
BJ Stream A	50	4.64	4.92	1.07	5.95	9.30	5.50	15	9	9
"Stock Pond"	70	61.50	65.50	1.75	34.50	38.20	33.60	88	63	11
WASTE ROCK/SOILS:										
BJ #1	2400 - 2700	890.00	910.00		1150.00	1060.00	860.00	830	74	9
BJ #3B	150 - 200	140.00	142.00		175.00	72.00	93.00	66	5	<5
BJ #3C	4500	5840.00	5730.00		5990.00	5600.00	4320.00	260	310	<5

NOTES:
A. Analyses done by NM Scientific Laboratory Division, Albuquerque
B. ur/hr = micro-roentgen per hour
C. pCi/g = picoCuries per gram
D. Radionuclides analyzed of the uranuim decay chain
E. Other elements commonly associated with uranium include arsenic, selenium, vanadium, and copper.

REFERENCES

41-44

Superfund Site Strategy Recommendation Region 6

Site Name: Navajo - Brown Vandever Uranium Mine Site Number: NMD986669117

Alias Site Name(s):

Address: Four Miles ENE of Bluewate, NM

City/County or Parish/State/Zip: Bluewater/McKinley/NM/87045

Recommendation:

[ ] 1. No further remedial action planned under Superfund.

[XX] 2. Further pre-remedial investigative action needed under Superfund:
PA ____ Priority: High XX
SSI XX ____ Medium ____
To be performed by Navajo

[ ] 3. Action may be appropriate under other authority:
NPDES ____ SPCC ____ 404 ____ TSCA ____
UIC ____ SMCRA ____ STATE ____ RCRA ____
OTHER ERB

Discussion: PA

The Brown Vandever Mine contains about 1880 tons of uranium mine tailings abandoned on-site. Small quantities of ore grade material are found scattered over the site. The material is easily accessible by site residents and visitors. There are several uncovered ventilation shafts, timbered shfts and inclined adits on the site. There are no warning signs or fences preventing access to the site. The population within 1/4 mile of the site is around 75 persons. Over 30 children are known to play on the tailings in the immediate vicinity of the mine. The road to the site is paved with tailings. There is potential for exposure of individuals via the air pathway as some of the material is fine, and Radon is also emitted from the slag material. The primary substances of concern are Uranium, and its progeny Th 232, Bi 214, Po 214, isotopes of Pb and Radon gas. The heavy metals potentially present in the mining waste are arsenic, barium, magnesium, manganese, strontium, titanium, and zinc. Many of these materials have been demonstrated to be mobile in waters associated with Uranium mines. Three wells and a spring are located within a 4 mile radius, and serve approximately 430 persons. Ground water from 2 of the wells is at 400 feet. The adits from the mine reach to within 100 feet of the groundwater and might convey contaminants. There is no surface source of water used by the people for drinking water. Because of the air pathway and soil exposure routes as well as the potential for ground water ntamination, this site is recommended for a Screening Site Inspection.

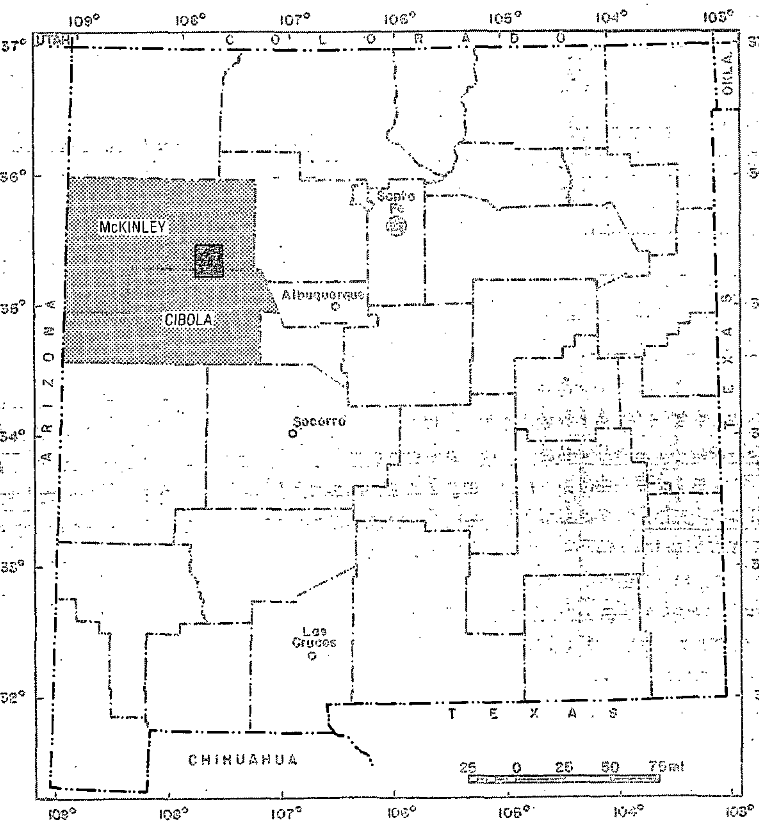
Copies to (please list) NAVAJO SF, 6T-AS, 6E-E, 6W-S, ATSDR

Recommended By: Barbara Driscoll Date: 7/17/90

Approved By: Bill Taylor for Betty B. Williamson Date: 7/17/90

Hydrogeology of Ambrosia Lake–San Mateo area, McKinley and Cibola Counties, New Mexico

by ROBERT C. BROD and WILLIAM J. STONE



Location of Ambrosia Lake-San Mateo area

HYDROGEOLOGIC SHEET 2 New Mexico Bureau of Mines & Mineral Resources 1981

A DIVISION OF

NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

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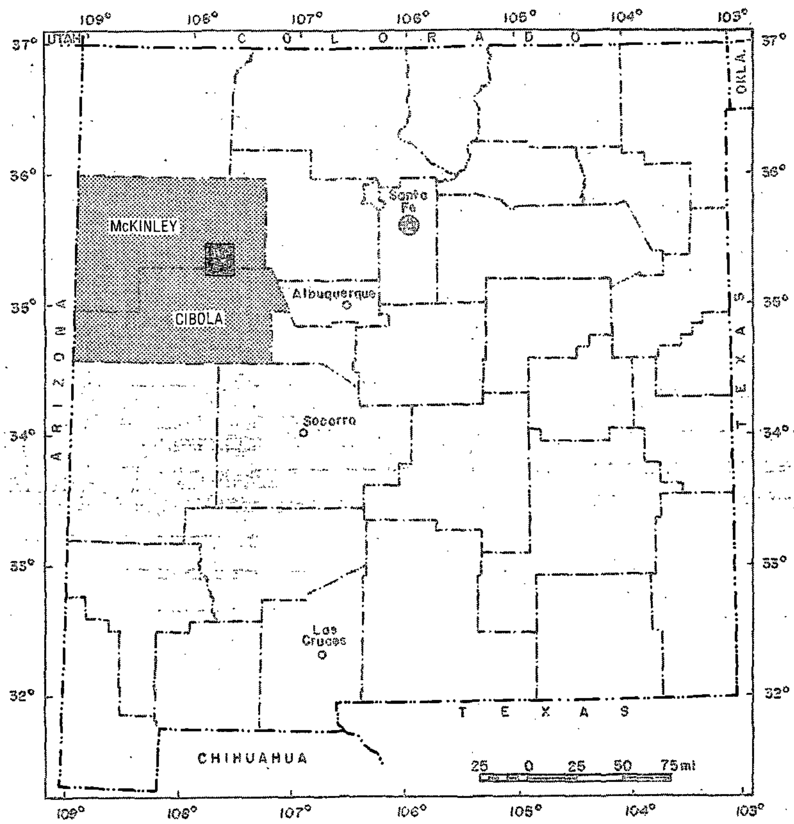

Location of Ambrosia Lake-San Mateo area

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NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

...lowered piezometric levels in the area.

77 In the Ambrosia Lake area, piezometric levels have been lowered hundreds of feet (t... meters) after more than 20 yrs of pumping. Dewatering has not yet had an ...ficant impact on piezometric levels in the eastern part of the area where ne... elopment is underway. The tremendous amounts of ground water that are pumped by the mining industry have great potential for uses in addition to ore processing. Most of the pumped water is now released into surface drainages, where it evaporates or infiltrates to recharge local aquifers before leaving the area. The possibility of treating waste water and diverting it for agricultural and municipal use has been considered by Hiss (1977).

TABLE 5—ESTIMATED DISCHARGE ASSOCIATED WITH URANIUM-MINE DEWATERING, AMBROSIA LAKE–SAN MATEO AREA (compiled from New Mexico Environmental Improvement Agency, 1978).

Company, mine	Estimated discharge million gallons per day	(million liters per day)
Gulf, Mt. Taylor mine	1.70[1]	(6.40)
	8.60[2]	(32.55)
Cobb Nuclear, sec. 14, T. 14 N., R. 10 W.	(water used and recycled)	
Kerr-McGee, Section 30 mine	0.56	(2.13)
Kerr-McGee, Sections 35 and 36 mines	4.32	(16.35)
Ranchers, Johnny M mine	2.88	(10.90)
Kerr-McGee, Roca Honda mine (planned; sec. 9, T. 13 N., R. 8 W.	3.60	(13.63)
United Nuclear–Homestake, recovery plant (for mines in secs. 15, 23, 25, and 32)	2.13	(8.07)
United Nuclear, Sandstone mine	0.51	(1.93)
United Nuclear, Section 27 mine	0.14	(0.53)
Ranchers, Faith mine	1.01	(3.82)

[1]Approximate discharge, January 1978
[2]Approximate anticipated discharge at start of mining

Municipalities

78 San Mateo is the only municipality in the study area operating a public water supply. Water is obtained from three wells that tap the Point Lookout Sandstone. The first municipal well (13.8.26.212) was drilled in the 1940's, but most homes continued to use private wells. The second well (13.8.26.112), drilled in 1955, provided the public supply at the time of this study. The water is not treated. The third well (13.8.26.212), constructed for the community by Gulf Mineral Resources in 1977, was not in use, reportedly because the second well provided an adequate supply.

79 Most dwellings in San Mateo now rely on the municipal supply, and only about eight private wells are still used (Nancy Brooks, representative, San Mateo Mutual Water-consumers Association, San Mateo, personal communication, 1977). Since 1970 a few new wells have been installed for trailer parks. An estimated 18,000 gpd (68 m³/d) are used in the town (Everheart, 1977).

80 Since the beginning of the construction of the Mt. Taylor mine, ½ mi (0.8 km) northeast of San Mateo, no general changes in the ground-water level or quality have been observed near the town. Gulf will mine uranium ore from the Westwater Canyon Member of the Morrison, approximately 3,200 ft (975 m) below ground level. Because San Mateo obtains water from aquifers recharged by runoff from Mount Taylor, the water supply will probably continue to be hydrologically independent of the ore-bearing strata and subsurface mining activity. Gulf will have a tailings pond adjacent to the mine. Although the pond will be lined, leachate could enter the shallow aquifer if the lining, retaining

New Mexico Environmental Improvement Agency, 1978, Grants mineral belt: Santa ... New Mexico Environmental Improvement Agency, unpublished field-...uidebook, 56 p.
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Tuan, Y.F., Everard, C.E., and Eiddison, J.G., 1969, The climate of New Mexico: Santa Fe, State Planning Office, Resources Planning Division, 170 p.
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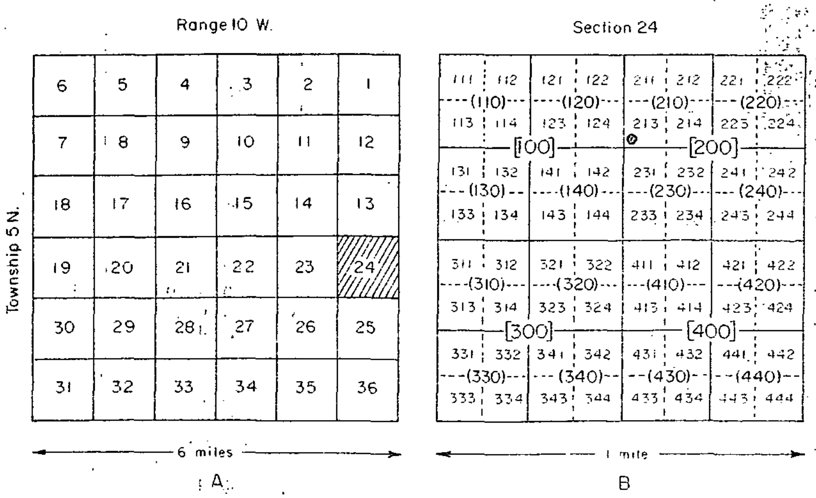

FIGURE 10—NEW MEXICO WELL-NUMBERING SYSTEM; well indicated by dot would be numbered 5.10.24.213.

2

eids less than 10 gpm (1 L/s). A sample from well
tively large amounts of sodium and sulfate and about
. Overlying aquifers generally yield water of more

odilto Limestone (Jurassic)

ne Todilto Limestone caps the cliffs of the Entrada
Montañosa and La Jara Mesa. It is approxi-
odilto occurs in thin to medium discontinuous
ypsum in the upper part.
a are completed in the Todilto; one is used for dewa-
abandoned domestic well. In outcrop, the Todilto is
ough the fractures may locally be filled with calcite,
nit water. Cooper and John (1968) reported that the
ine, which is constructed in the Todilto Limestone,
at the time of their report. The dewatering rate now
m (38–57 L/s; Mark Malkoski, geologist, Ranchers
nent, Grants, personal communication, 1977). The
be expected to be high in sulfate and TDS, reflecting
ne unit.

hinle Formation (Triassic)

on crops out on the flanks of the Zuni Mountains and
ft (30 m) of alluvium in the southwest corner of the
ndicate that it is approximately 1,350 ft (412 m) thick
consists of clayey siltstone interbedded with sand-

ribed three units in the Chinle Formation near the
is approximately 900 ft (274 m) thick and consists of
erbedded with sandstone; it contains lenses of fine-
er third. The middle unit, 100–200 ft (30–61 m) thick,
ndstone and conglomerate interbedded with siltstone
e trace on geophysical logs. The lower Chinle unit is
ick and consists of silty sandstone interbedded with
ed sandstone at its base.
udy area are completed in the Chinle; these wells sup-
ranch house. Gordon (1961) indicated that yields are
(1 L/s) and are variable because of the interbedded
, water quality is variable. A well completed in
3.431, table 3) produces water with a specific
/cm (micromhos per centimeter). One completed at
) below the surface (12.10.1.222) produced water with
8,000 μmhos. The water is generally enriched with
ride, and sulfate. Cooper and John (1968) indicated
of the Chinle is used as an aquifer west of the study

imestone–Glorieta Sandstone (Permian)

nestone and Glorieta Sandstone crop out on the flanks
ith of the study area. Together they compose an im-
wn of Bluewater in Cibola County. Although they are
eep in the study area, they have been used locally as a

rted that the San Andres is 80–150 ft (24–46 m) thick
sists of two units of limestone divided by a unit of me-
sandstone, 15–30 ft (5–9 m) thick. Extensive solution
d channels and caverns that, though commonly filled
large amounts of water.
tone, lying directly under the San Andres, is 125–300
region and consists of well-sorted, medium-grained,
less permeable than the San Andres, and wells rarely
with the San Andres, however, it forms a large single

iations in permeability, the yields and quality of water
rieta aquifer also vary from place to place. Gordon
00–2,200 gpm (32–139 L/s) from wells near Bluewater
ndy area. Cooper and John (1968) reported yields of
d indicated that two wells in the Ambrosia Lake area
41… table 2) were completed in this aquifer but aban-
f better water at shallower depths. Water from
TDS concentration of 2,370 ppm (table 3). Ac-
es reported by Cooper and John (1968, table 3), this
water elsewhere in the region with a TDS concentra-
ufmann and others (1975) indicated that wells drawing
lorieta aquifer now contribute feed water to the

ND-WATER MOVEMENT

58 In the … ally conforms to … water in such settings is … in the alluvium indicate the tenden… parallel to the course of Arroyo del … toward the southwest part of the study area … the Menefee Formation near San Mateo indicate that … the upper part of that unit generally parallels the path of … than the direction of the dip of the strata (fig. 5).

59 Ground water in the consolidated units, however, is part of … deeper flow system that is controlled largely by the geologic structure. Fig. … map of the potentiometric surface for the Westwater Canyon Member of the Morrison, based on water-level measurements obtained in the late 1950's by Cooper and John (1968). Their data reflect conditions before the large-scale dewatering of the uranium mines. Many of the wells near Ambrosia Lake are now reportedly dry; mining has dewatered virtually all of the ground water in the Westwater Canyon Member there and has dramatically altered the flow system in it. However, fig. 7 shows that prior to mine dewatering, ground water in the Westwater Canyon Sandstone Member generally flowed in the direction of the dip of the strata to the northeast and east. Virtually horizontal structure at the crest of San Mateo dome (cross section, fig. 1) and the relatively high concentration of TDS in the units there (fig. 6) suggest that relatively little ground-water movement occurs in the deeper flow system in that area. The dome and associated San Mateo fault seem to define a regional ground-water divide that corresponds to the boundary between the Chaco slope and the Acoma sag as described by Kelley (1963).

60 The rate and direction of ground-water flow in the consolidated aquifers is controlled by both the intergranular and fracture permeability of the strata as well as by the potentiometric gradient. Jobin (1962) performed laboratory analyses to determine the intrinsic permeability of samples from the geologic units near Grants. The Westwater Canyon Sandstone has the greatest intrinsic permeability, equivalent to a hydraulic conductivity of about 0.10 gpd/ft² (4.07 L/m²d). The other sandstone units have intrinsic permeabilities equivalent to hydraulic conductivities between 0.01 and 0.10 gpd/ft² (0.41 and 4.07 L/m²d). Despite its relatively coarse and well-sorted texture, the Bluff has the lowest intrinsic permeability of the sandstones in the area; the values would convert to a hydraulic conductivity of 0.01 gpd/ft² (0.41 L/m²d). This unit is very calcareous in its outcrop, and the abundant calcite cement may be responsible for the low permeability. Calcite cement in the Bluff Sandstone may have been derived from the Todilto or from the limestone beds in the Recapture Member of the Morrison Formation.

61 Aquifer tests provide a means of assessing the overall permeability (intergranular and fracture) of the aquifer (table 4). Values determined for the Westwater Canyon Member of the Morrison indicate that its hydraulic conductivity is quite variable, presumably depending upon the degree of fracturing. The highest measurement of hydraulic conductivity for the Westwater Canyon in the study area was made near San Mateo in the proximity of the San Rafael fault zone on the western flank of the McCartys syncline. Table 4 shows that field measurements of hydraulic conductivity in the area, which include the effects of fracture permeability, tend to be approximately 100 times greater than those determined in the laboratory (which do not include effects of fractures).

62 The effects of fracturing on ground-water flow vary according to the type of rock, the amount and type of displacement, and the orientation of the fractures. Gorham and others (1977) indicated that joints created by tensional forces tend to be parallel and open and therefore provide relatively more permeability. This type of jointing also tends to be oriented parallel to the axes of the associated folds. In some parts of the area, gouge and cement in the fracture zones inhibit ground-water flow. Flow is also inhibited where relatively permeable beds are displaced against relatively impermeable ones.

TABLE 4—RESULTS OF PUMPING TESTS IN AMBROSIA LAKE–SAN MATEO AREA.

Formation	Locality/Source	T gpd/ft	T (L/md)	K gpd/ft²	K (L/m²d)
Point Lookout Sandstone	San Mateo/1	1,500	(18,600)	11	(448)
Mancos Shale (sandstone)	San Mateo/1	1,000	(12,400)	20	(815)
Dakota Sandstone	San Mateo/1	1,000	(12,400)	12	(489)
Westwater Canyon Member,	San Mateo/1	3,700	(45,900)	24	(978)
Morrison Formation	Ambrosia Lake/2	1,300	(16,100)	8.1	(330)
	Ambrosia Lake/3	1,500	(18,600)	10	(407)
Glorieta Sandstone	Fort Wingate/4	400	(4,900)	1.6	(65)
	Fort Wingate/5	130	(1,600, average)	0.5	(20)

Sources:
1—H. Jukenwold, hydrologist, Gulf Minerals, Denver, personal communication
2—Cooper and John (1967)
3—Kelley (1977)
4—Mercer and Lappala (1971)

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Water System Details

Water System No. :	NM3595017	**Federal Type :**	NTNC
Water System Name :	TRI-STATE GENERATING STATION	**State Type :**	NTNC
Principal County Served :	MCKINLEY	**Primary Source :**	SW
Status :	A	**Activity Date :**	04-01-1981

Points of Contact

Name	Job Title	Type	Phone	Address	Email
ARMENTA, JOHNNY	null	OP	505-876-5232	PO BOX 577, PREWITT, NM-87045	Not Available
WALZ, BARBARA A.		AC	303-254-3184	PO Box 33695, Tri-State Generation & Transmission Asso, DENVER, CO-80233-0695	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	NT	125

Service Connections

Type	Count
CB	5

Sources of Water

Name	Type Code	Status
WELL #11	WL	I
WELL #6	WL	I
WELL #7	WL	A
WELL #8	WL	A

Service Areas

Code	Name
NT	INDUSTRIAL/AGRICULTURAL

WELL #9	WL	A
WELL #10	WL	A
RESERVOIR #1	RS	A
WELL #1	WL	A
WELL #2	WL	A
WELL #4	WL	A
WELL #5	WL	A

Water Purchases

Seller Water System No.	Water System Name	Seller Water Type	Purchase Date	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Water System No. :	NM3595017	**Federal Type :**	NT
Water System Name :	TRI-STATE GENERATING STATION	**State Type :**	NT
Principal County Served :	MCKINLEY	**Primary Source :**	SW
Status :	A	**Activity Date :**	04-
Lab Sample No. :	180631001	**Collection Date :**	02-

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	M P
4000	GROSS ALPHA, EXCL. RADON & U	900	Y	MRL	1.96 PCI/L		01-01-2004	1
4000	GROSS ALPHA, EXCL. RADON & U	900	Y	MRL	1.96 PCI/L		01-01-2004	1
4010	COMBINED RADIUM (-226 & -228)	null	Y	MRL	0.725 PCI/L	0		
4010	COMBINED RADIUM (-226 & -228)	null	Y	MRL	0.725 PCI/L	0		
4020	RADIUM-226	903.1	Y	MRL	0.725 PCI/L		01-01-2004	1
4020	RADIUM-226	903.1	Y	MRL	0.725 PCI/L		01-01-2004	1
4030	RADIUM-228	904.0	Y	MRL	0.702 PCI/L		01-01-2004	1
4030	RADIUM-228	904.0	Y	MRL	0.702 PCI/L		01-01-2004	1
4100	GROSS BETA PARTICLE ACTIVITY	900	N	MRL	2.59 PCI/L	123 PCI/L	01-01-2004	1
4100	GROSS BETA PARTICLE ACTIVITY	900	N	MRL	2.59 PCI/L	123 PCI/L	01-01-2004	1

Total Number of Records Fetched = 10

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Water System Details

Water System No. :	NM3591033	**Federal Type :**	C
Water System Name :	ARCO (ANACONDA) COAL CO - BLUEWATER MILL	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	I	**Activity Date :**	08-01-1996

Points of Contact

Name	Job Title	Type	Phone	Address	Email

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	60

Service Connections

Type	Count
CB	5

Sources of Water

Name	Type Code	Status
WELL # 1	WL	I
WELL # 2	WL	I
WELL # 3	WL	I
WELL # 4	WL	I

Service Areas

Code	Name
R	OTHER RESIDENTIAL AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Water Type	Purchase Date	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Water System Details

Water System No. :	NM3591033	**Federal Type :**	C
Water System Name :	ARCO (ANACONDA) COAL CO - BLUEWATER MILL	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	I	**Activity Date :**	08-01-1996

Points of Contact

Name	Job Title	Type	Phone	Address	Email

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	60

Service Connections

Type	Count
CB	5

Sources of Water

Name	Type Code	Status
WELL # 1	WL	I
WELL # 2	WL	I
WELL # 3	WL	I
WELL # 4	WL	I

Service Areas

Code	Name
R	OTHER RESIDENTIAL AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Water Type	Purchase Date	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Water System Details

Water System No. :	NM3598133	**Federal Type :**	NC
Water System Name :	HOMESTAKE MILL	**State Type :**	NC
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	I	**Activity Date :**	06-12-1990

Points of Contact

Name	Job Title	Type	Phone	Address	Email
KENNEDY, ED	null	OP	505-287-4456	PO BOX 8, GRANTS, NM-87020	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	T	24

Service Connections

Type	Count
CB	17

Sources of Water

Name	Type Code	Status
WELL # 1	WL	I

Service Areas

Code	Name
T	OTHER TRANSIENT AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Water Type	Purchase Date	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

EPA/540/G-91/013
Publication 9345.0-01A
September 1991

Guidance for Performing Preliminary Assessments Under CERCLA

Hazardous Site Evaluation Division
Office of Emergency and Remedial Response
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, DC 20460

3.3.2. Targets

Ground water pathway targets are drinking water supply wells within 4 miles of the site. For every PA site, you must develop a good understanding of the drinking water supply situation within the 4-mile target distance limit, and perform a comprehensive survey of drinking water supply systems and the number of people they serve. Very often, drinking water is supplied by some combination of domestic wells serving individual residences, community wells serving multiple residences, municipal wells serving entire towns or cities, and surface water supplies. For the ground water pathway, you are specifically concerned with private and public drinking water supply wells but, in the course of developing information about water supplies, you must also find out about surface water sources of drinking water (Section 3.4.2).

Your survey must be comprehensive enough to allow you to identify, on a topographic map, the location of each municipal drinking water well and surface water intake supplying drinking water within the target distance limit. Delineate on the map the specific geographic areas where drinking water is supplied by: municipal wells, municipal intakes, private and community wells, and private and community intakes. Note that, in some areas, private water companies supply drinking water to large numbers of people. These systems also fall within the meaning of a "municipal" system.

Multiple-Aquifer Systems

In researching the local water supply situation, you may find that drinking water is drawn from more than one aquifer. In many areas, multiple-aquifer systems provide drinking water from different aquifers at different depths. In such situations, the deeper aquifer(s) may or may not be at risk from a release from the site, depending on whether it is hydrogeologically isolated from overlying aquifers. Often, the extent to which one aquifer may be either isolated from or in hydraulic communication with another aquifer is not easily determined and even hydrogeologic experts may disagree. For these reasons, the PA evaluation of populations drinking ground water includes all persons served by all aquifers. Nonetheless, when researching drinking water populations, it is a good practice to develop as much information as possible concerning the populations associated with specific aquifers; such information may be useful to the SI if the site advances to that stage.

Municipal Drinking Water Supplies

The best place to begin a water supply survey is the local municipal and county water authorities. Bring your topographic map and ask the appropriate officials to locate municipal drinking water wells and intakes, including those that might be designated as "standby" or "backup," and to delineate the municipal distribution system. Very often, the entire system is interconnected -- by way of valves or connecting lines -- so that water drawn from any individual well or intake has the potential to reach any user of the system. This is referred to as a "blended system." In other cases, separate distribution systems function independently and do not have the capability for interconnection with other systems. Identify the specific systems that are blended, and the specific systems that are independent. You also need to know either the number of people served or the number of service connections in each blended and independent system, which wells and intakes supply each system, and the average annual production from each well and intake.

Drinking Water Supplies in Areas Not Served by a Municipal System

After identifying municipal wells, intakes, and distribution systems, investigate water supplies in areas outside of the municipal systems. People in these areas probably obtain water from private

COMPOSITION
B O O K

Frank V. Del[illegible]

COLLEGE RULED/MARGIN

80 Sheets • 10" x 7 7/8"

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(8)

1/7/2008 @ 1300
Telecomference w/ LaDonna, Al, Brenda re 4-mile radius map for SMC Basin PA

- Proper way would be through intersecting circles. However probably not worth effort since basin likely will be divided into sections. Therefore call out population centers, population distribution, HHCs municipal wells. 4-mile radius not required.

- EPA can provide GIS support; contractor could come to SF.

David L Rope

1/14/2008

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Water System Details

Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
HAYES, ROBERT	null	OP	505-287-2908	121 Wayne Av, GRANTS, NM-87020	Not Available
HORACEK, BOB	CITY MANAGER	EC	505-287-7927	PO Box 879, GRANTS, NM-87020	Not Available
MARTINEZ, ANTHONY		AC	505-287-2908	PO Box 702, GRANTS, NM-87020	anthony.martinez@ch2m.com

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	8892

Service Connections

Type	Count
CB	3211

Sources of Water

Name	Type Code	Status
WELL # 1	WL	A
WELL # 2	WL	I
WELL # 3	WL	A

Service Areas

Code	Name
R	RESIDENTIAL AREA

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC200000584	**Collection Date :**	06-15-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.4 PCI/L	6.8 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.4 PCI/L	6.8 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.2 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.2 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.5 PCI/L	8.1 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.5 PCI/L	8.1 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3526133		
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**Federal Type :**	C
Principal County Served :	CIBOLA	**State Type :**	C
Status :	A	**Primary Source :**	GW
Lab Sample No. :	RC200000587	**Activity Date :**	06-01-1977
		Collection Date :	06-15-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitoring Period End Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.3 PCI/L	6.8 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.3 PCI/L	6.8 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.32 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.32 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.4 PCI/L	8.1 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.4 PCI/L	8.1 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC960294	**Collection Date :**	06-18-1996

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.4 PCI/L	5.1 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.4 PCI/L	5.1 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.25 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.25 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.7 PCI/L	4.9 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.7 PCI/L	4.9 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC960295	**Collection Date :**	06-18-1996

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.1 PCI/L	5.8 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.1 PCI/L	5.8 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	2 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	2 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.3 PCI/L	5.5 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.3 PCI/L	5.5 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM-200200263	**Collection Date :**	03-06-2002

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	200.8	N	MRL	0.001 MG/L	0.004 MG/L	01-01-2002	12-31-:
1010	BARIUM	200.8	Y	MRL	0.1 MG/L	null	01-01-2002	12-31-:
1015	CADMIUM	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-:
1020	CHROMIUM	200.8	N	MRL	0.001 MG/L	0.001 MG/L	01-01-2002	12-31-:
1035	MERCURY	200.8	Y	MRL	0.0002 MG/L	null	01-01-2002	12-31-:
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null	01-01-2002	12-31-:
1045	SELENIUM	200.8	N	MRL	0.005 MG/L	0.007 MG/L	01-01-2002	12-31-:
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-:
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-:
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	MG/L	01-01-2002	12-31-:

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200200264	**Collection Date :**	03-06-2002

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	200.8	N		0.001 MG/L	.004 MG/L	01-01-2002	12-31-
1010	BARIUM	200.8	Y	MRL	0.1 MG/L	null	01-01-2002	12-31-
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null	01-01-2002	12-31-
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null	01-01-2002	12-31-
1045	SELENIUM	200.9	N		0.005 MG/L	.007 MG/L	01-01-2002	12-31-
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null	01-01-2002	12-31-

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200200263	**Collection Date :**	03-06-2001

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	200.8	N		0.001 MG/L	.004 MG/L		
1010	BARIUM	200.8	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	200.8	N		0.001 MG/L	.001 MG/L		
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null		
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null		
1045	SELENIUM	200.9	N		0.005 MG/L	.007 MG/L		
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null		
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200001349	**Collection Date :**	07-17-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	null	N		0.001 MG/L	.002 MG/L		
1010	BARIUM	null	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	null	Y	MRL	0.001 MG/L	null		
1035	MERCURY	null	Y	MRL	0.0002 MG/L	null		
1036	NICKEL	null	Y	MRL	0.01 MG/L	null		
1045	SELENIUM	null	N		0.005 MG/L	.006 MG/L		
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200001350	**Collection Date :**	07-17-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monito Period Dat
1005	ARSENIC	null	N		0.001 MG/L	.002 MG/L		
1010	BARIUM	null	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	null	Y	MRL	0.001 MG/L	null		
1035	MERCURY	null	Y	MRL	0.0002 MG/L	null		
1036	NICKEL	null	Y	MRL	0.01 MG/L	null		
1045	SELENIUM	null	Y	MRL	0.005 MG/L	null		
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Glossary

Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200000567	**Collection Date :**	05-03-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	200.8	N		0.001 MG/L	.002 MG/L		
1010	BARIUM	200.8	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L	null		
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null		
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null		
1045	SELENIUM	200.9	N		0.005 MG/L	.006 MG/L		
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null		
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM200000568	**Collection Date :**	05-03-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	200.8	Y	MRL	0.001 MG/L	null		
1010	BARIUM	200.8	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	200.8	Y	MRL	0.001 MG/L	null		
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null		
1036	NICKEL	200.8	Y	MRL	0.01 MG/L	null		
1045	SELENIUM	200.9	N		0.005 MG/L	.006 MG/L		
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null		
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM9701205	**Collection Date :**	08-20-1997

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	null	Y	MRL	0.001 MG/L	null		
1010	BARIUM	null	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	null	N		0.001 MG/L	.001 MG/L		
1035	MERCURY	null	Y	MRL	0.0002 MG/L	null		
1036	NICKEL	null	Y	MRL	0.01 MG/L	null		
1045	SELENIUM	null	N		0.005 MG/L	.007 MG/L		
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM9701206	**Collection Date :**	08-20-1997

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	null	N		0.001 MG/L	.001 MG/L		
1010	BARIUM	null	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	null	Y	MRL	0.001 MG/L	null		
1035	MERCURY	null	Y	MRL	0.0002 MG/L	null		
1036	NICKEL	null	Y	MRL	0.01 MG/L	null		
1045	SELENIUM	null	N		0.005 MG/L	.006 MG/L		
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM940509	**Collection Date :**	01-25-1994

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monito Period Dat
1005	ARSENIC	null	N		0 null	.002 MG/L		
1010	BARIUM	null	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	null	N		0 null	.002 MG/L		
1035	MERCURY	null	Y	MRL	0.0005 MG/L	null		
1036	NICKEL	null	Y	MRL	0.005 MG/L	null		
1045	SELENIUM	null	Y	MRL	0.005 MG/L	null		
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.0005 MG/L	null		
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	C
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	HM940510	**Collection Date :**	01-25-1994

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monit Period Dat
1005	ARSENIC	null	N		0 null	.004 MG/L		
1010	BARIUM	null	Y	MRL	0.1 MG/L	null		
1015	CADMIUM	null	Y	MRL	0.001 MG/L	null		
1020	CHROMIUM	null	Y	MRL	0.005 MG/L	null		
1035	MERCURY	null	Y	MRL	0.0005 MG/L	null		
1036	NICKEL	null	Y	MRL	0.005 MG/L	null		
1045	SELENIUM	null	Y	MRL	0.005 MG/L	null		
1074	ANTIMONY, TOTAL	null	Y	MRL	0.001 MG/L	null		
1075	BERYLLIUM, TOTAL	null	Y	MRL	0.0005 MG/L	null		
1085	THALLIUM, TOTAL	null	Y	MRL	0.001 MG/L	null		

Total Number of Records Fetched = 10

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Water System No. :	NM3526133	**Federal Type :**	
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	
Principal County Served :	CIBOLA	**Primary Source :**	
Status :	A	**Activity Date :**	
Lab Sample No. :	17857	**Collection Date :**	2-22-05

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentratic level
1005	ARSENIC	200.8	N	MRL	0.001 MG/L	0.00800 MG/I
1010	BARIUM	200.8	N	MRL	0.002 MG/L	0.0320 MG/L
1015	CADMIUM	200.8	Y	MRL	0.001 MG/L	null
1020	CHROMIUM	200.8	N	MRL	0.001 MG/L	0.0230 MG/L
1024	CYANIDE	4500CN-E	Y	MRL	0.005 MG/L	null
1025	FLUORIDE	300.0	N	MRL	0.2 MG/L	0.426 MG/L
1030	LEAD	200.8	N	MRL	0.001 MG/L	0.00900 MG/I
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null
1036	NICKEL	200.8	N	MRL	0.001 MG/L	0.0100 MG/L
1038	NITRATE-NITRITE	300.0	N	MRL	0.05 MG/L	1.77 MG/L
1041	NITRITE	300.0	Y	MRL	0.05 MG/L	null
1045	SELENIUM	200.8	N	MRL	0.002 MG/L	0.0110 MG/L
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null
2005	ENDRIN	505	Y	MRL	0.01 UG/L	null
2005	ENDRIN	505	Y	MRL	0.01 UG/L	null
2010	BHC-GAMMA	505	Y	MRL	0.01 UG/L	null
2010	BHC-GAMMA	505	Y	MRL	0.01 UG/L	null
2015	METHOXYCHLOR	505	Y	MRL	0.05 UG/L	null

2015	METHOXYCHLOR	505	Y	MRL	0.05 UG/L	null
2020	TOXAPHENE	505	Y	MRL	0.5 UG/L	null
2020	TOXAPHENE	505	Y	MRL	0.5 UG/L	null
2031	DALAPON	515.1	Y	MRL	0.25 UG/L	null
2031	DALAPON	515.1	Y	MRL	0.25 UG/L	null
2032	DIQUAT	null	Y	MRL	0.4 UG/L	null
2032	DIQUAT	null	Y	MRL	0.4 UG/L	null
2033	ENDOTHALL	548.1	Y	MRL	9 UG/L	null
2033	ENDOTHALL	548.1	Y	MRL	9 UG/L	null
2034	GLYPHOSATE	547	Y	MRL	6 UG/L	null
2034	GLYPHOSATE	547	Y	MRL	6 UG/L	null
2035	DI(2-ETHYLHEXYL) ADIPATE	525.2	Y	MRL	0.6 UG/L	null
2035	DI(2-ETHYLHEXYL) ADIPATE	525.2	Y	MRL	0.6 UG/L	null
2036	OXAMYL	531.1	Y	MRL	2 UG/L	null
2036	OXAMYL	531.1	Y	MRL	2 UG/L	null
2037	SIMAZINE	507	Y	MRL	0.07 UG/L	null
2037	SIMAZINE	507	Y	MRL	0.07 UG/L	null
2039	DI(2-ETHYLHEXYL) PHTHALATE	525.2	Y	MRL	0.6 UG/L	null
2039	DI(2-ETHYLHEXYL) PHTHALATE	525.2	Y	MRL	0.6 UG/L	null
2040	PICLORAM	515.1	Y	MRL	0.1 UG/L	null
2040	PICLORAM	515.1	Y	MRL	0.1 UG/L	null
2041	DINOSEB	515.1	Y	MRL	0.25 UG/L	null
2041	DINOSEB	515.1	Y	MRL	0.25 UG/L	null
2042	HEXACHLOROCYCLOPENTADIENE	505	Y	MRL	0.1 UG/L	null
2042	HEXACHLOROCYCLOPENTADIENE	505	Y	MRL	0.1 UG/L	null
2043	ALDICARB SULFOXIDE	531.1	Y	MRL	20 UG/L	null
2043	ALDICARB SULFOXIDE	531.1	Y	MRL	20 UG/L	null
2044	ALDICARB SULFONE	531.1	Y	MRL	20 UG/L	null
2044	ALDICARB SULFONE	531.1	Y	MRL	20 UG/L	null
2046	CARBOFURAN	531.1	Y	MRL	0.9 UG/L	null

2046	CARBOFURAN	531.1	Y	MRL	0.9 UG/L	null
2047	ALDICARB	531.1	Y	MRL	20 UG/L	null
2047	ALDICARB	531.1	Y	MRL	20 UG/L	null
2050	ATRAZINE	507	Y	MRL	0.1 UG/L	null
2050	ATRAZINE	507	Y	MRL	0.1 UG/L	null
2051	LASSO	507	Y	MRL	0.2 UG/L	null
2051	LASSO	507	Y	MRL	0.2 UG/L	null
2065	HEPTACHLOR	505	Y	MRL	0.01 UG/L	null
2065	HEPTACHLOR	505	Y	MRL	0.01 UG/L	null
2067	HEPTACHLOR EPOXIDE	505	Y	MRL	0.01 UG/L	null
2067	HEPTACHLOR EPOXIDE	505	Y	MRL	0.01 UG/L	null
2105	2,4-D	515.1	Y	MRL	0.1 UG/L	null
2105	2,4-D	515.1	Y	MRL	0.1 UG/L	null
2110	2,4,5-TP	515.1	Y	MRL	0.2 UG/L	null
2110	2,4,5-TP	515.1	Y	MRL	0.2 UG/L	null
2274	HEXACHLOROBENZENE	505	Y	MRL	0.1 UG/L	null
2274	HEXACHLOROBENZENE	505	Y	MRL	0.1 UG/L	null
2306	BENZO(A)PYRENE	550	Y	MRL	0.02 UG/L	null
2306	BENZO(A)PYRENE	550	Y	MRL	0.02 UG/L	null
2326	PENTACHLOROPHENOL	515.1	Y	MRL	0.04 UG/L	null
2326	PENTACHLOROPHENOL	515.1	Y	MRL	0.04 UG/L	null
2378	1,2,4-TRICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2378	1,2,4-TRICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2380	CIS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2380	CIS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2383	TOTAL POLYCHLORINATED BIPHENYLS (PCB)	505	Y	MRL	0.1 UG/L	null
2383	TOTAL POLYCHLORINATED BIPHENYLS (PCB)	505	Y	MRL	0.1 UG/L	null
2931	1,2-DIBROMO-3-CHLOROPROPANE	504.1	Y	MRL	0.02 UG/L	null
2931	1,2-DIBROMO-3-CHLOROPROPANE	504.1	Y	MRL	0.02 UG/L	null
2946	ETHYLENE DIBROMIDE	504.1	Y	MRL	0.01 UG/L	null
2946	ETHYLENE DIBROMIDE	504.1	Y	MRL	0.01 UG/L	null

2955	XYLENES, TOTAL	524.2	Y	MRL	0.5 UG/L	null
2955	XYLENES, TOTAL	524.2	Y	MRL	0.5 UG/L	null
2959	CHLORDANE	505	Y	MRL	0.01 UG/L	null
2959	CHLORDANE	505	Y	MRL	0.01 UG/L	null
2964	DICHLOROMETHANE	524.2	Y	MRL	0.5 UG/L	null
2964	DICHLOROMETHANE	524.2	Y	MRL	0.5 UG/L	null
2968	O-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2968	O-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2969	P-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2969	P-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2976	VINYL CHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2976	VINYL CHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2977	1,1-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2977	1,1-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2979	TRANS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2979	TRANS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2980	1,2-DICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2980	1,2-DICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2981	1,1,1-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2981	1,1,1-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2982	CARBON TETRACHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2982	CARBON TETRACHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2983	1,2-DICHLOROPROPANE	524.2	Y	MRL	0.5 UG/L	null
2983	1,2-DICHLOROPROPANE	524.2	Y	MRL	0.5 UG/L	null
2984	TRICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2984	TRICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2985	1,1,2-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2985	1,1,2-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2987	TETRACHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2987	TETRACHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null

2989	CHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2989	CHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2990	BENZENE	524.2	Y	MRL	0.5 UG/L	null
2990	BENZENE	524.2	Y	MRL	0.5 UG/L	null
2991	TOLUENE	524.2	Y	MRL	0.5 UG/L	null
2991	TOLUENE	524.2	Y	MRL	0.5 UG/L	null
2992	ETHYLBENZENE	524.2	Y	MRL	0.5 UG/L	null
2992	ETHYLBENZENE	524.2	Y	MRL	0.5 UG/L	null
2996	STYRENE	524.2	Y	MRL	0.5 UG/L	null
2996	STYRENE	524.2	Y	MRL	0.5 UG/L	null

Total Number of Records Fetched = 121

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Water System No. :	NM3526133	**Federal Type :**	
Water System Name :	GRANTS DOMESTIC WATER SYSTEM	**State Type :**	
Principal County Served :	CIBOLA	**Primary Source :**	
Status :	A	**Activity Date :**	
Lab Sample No. :	17856	**Collection Date :**	2-22-05

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentratio level
1005	ARSENIC	200.8	N	MRL	0.001 MG/L	0.00500 MG/l
1010	BARIUM	200.8	N	MRL	0.002 MG/L	0.0320 MG/L
1015	CADMIUM	200.8	Y	MRL	0.001 MG/L	null
1020	CHROMIUM	200.8	N	MRL	0.001 MG/L	0.0200 MG/L
1024	CYANIDE	4500CN-E	Y	MRL	0.005 MG/L	null
1025	FLUORIDE	300.0	N	MRL	0.2 MG/L	0.497 MG/L
1030	LEAD	200.8	Y	MRL	0.001 MG/L	null
1035	MERCURY	245.1	Y	MRL	0.0002 MG/L	null
1036	NICKEL	200.8	N	MRL	0.001 MG/L	0.00300 MG/l
1038	NITRATE-NITRITE	300.0	N	MRL	0.05 MG/L	1.79 MG/L
1041	NITRITE	300.0	Y	MRL	0.05 MG/L	null
1045	SELENIUM	200.8	N	MRL	0.002 MG/L	0.0120 MG/L
1074	ANTIMONY, TOTAL	200.8	Y	MRL	0.001 MG/L	null
1075	BERYLLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null
1085	THALLIUM, TOTAL	200.8	Y	MRL	0.001 MG/L	null
2005	ENDRIN	505	Y	MRL	0.01 UG/L	null
2005	ENDRIN	505	Y	MRL	0.01 UG/L	null
2010	BHC-GAMMA	505	Y	MRL	0.01 UG/L	null
2010	BHC-GAMMA	505	Y	MRL	0.01 UG/L	null
2015	METHOXYCHLOR	505	Y	MRL	0.05 UG/L	null

2015	METHOXYCHLOR	505	Y	MRL	0.05 UG/L	null
2020	TOXAPHENE	505	Y	MRL	0.5 UG/L	null
2020	TOXAPHENE	505	Y	MRL	0.5 UG/L	null
2031	DALAPON	515.1	Y	MRL	0.25 UG/L	null
2031	DALAPON	515.1	Y	MRL	0.25 UG/L	null
2032	DIQUAT	null	Y	MRL	0.4 UG/L	null
2032	DIQUAT	null	Y	MRL	0.4 UG/L	null
2033	ENDOTHALL	548.1	Y	MRL	9 UG/L	null
2033	ENDOTHALL	548.1	Y	MRL	9 UG/L	null
2034	GLYPHOSATE	547	Y	MRL	6 UG/L	null
2034	GLYPHOSATE	547	Y	MRL	6 UG/L	null
2035	DI(2-ETHYLHEXYL) ADIPATE	525.2	Y	MRL	0.6 UG/L	null
2035	DI(2-ETHYLHEXYL) ADIPATE	525.2	Y	MRL	0.6 UG/L	null
2036	OXAMYL	531.1	Y	MRL	2 UG/L	null
2036	OXAMYL	531.1	Y	MRL	2 UG/L	null
2037	SIMAZINE	507	Y	MRL	0.07 UG/L	null
2037	SIMAZINE	507	Y	MRL	0.07 UG/L	null
2039	DI(2-ETHYLHEXYL) PHTHALATE	525.2	Y	MRL	0.6 UG/L	null
2039	DI(2-ETHYLHEXYL) PHTHALATE	525.2	Y	MRL	0.6 UG/L	null
2040	PICLORAM	515.1	Y	MRL	0.1 UG/L	null
2040	PICLORAM	515.1	Y	MRL	0.1 UG/L	null
2041	DINOSEB	515.1	Y	MRL	0.25 UG/L	null
2041	DINOSEB	515.1	Y	MRL	0.25 UG/L	null
2042	HEXACHLOROCYCLOPENTADIENE	505	Y	MRL	0.1 UG/L	null
2042	HEXACHLOROCYCLOPENTADIENE	505	Y	MRL	0.1 UG/L	null
2043	ALDICARB SULFOXIDE	531.1	Y	MRL	20 UG/L	null
2043	ALDICARB SULFOXIDE	531.1	Y	MRL	20 UG/L	null
2044	ALDICARB SULFONE	531.1	Y	MRL	20 UG/L	null
2044	ALDICARB SULFONE	531.1	Y	MRL	20 UG/L	null
2046	CARBOFURAN	531.1	Y	MRL	0.9 UG/L	null

2046	CARBOFURAN	531.1	Y	MRL	0.9 UG/L	null
2047	ALDICARB	531.1	Y	MRL	20 UG/L	null
2047	ALDICARB	531.1	Y	MRL	20 UG/L	null
2050	ATRAZINE	507	Y	MRL	0.1 UG/L	null
2050	ATRAZINE	507	Y	MRL	0.1 UG/L	null
2051	LASSO	507	Y	MRL	0.2 UG/L	null
2051	LASSO	507	Y	MRL	0.2 UG/L	null
2065	HEPTACHLOR	505	Y	MRL	0.01 UG/L	null
2065	HEPTACHLOR	505	Y	MRL	0.01 UG/L	null
2067	HEPTACHLOR EPOXIDE	505	Y	MRL	0.01 UG/L	null
2067	HEPTACHLOR EPOXIDE	505	Y	MRL	0.01 UG/L	null
2105	2,4-D	515.1	Y	MRL	0.1 UG/L	null
2105	2,4-D	515.1	Y	MRL	0.1 UG/L	null
2110	2,4,5-TP	515.1	Y	MRL	0.2 UG/L	null
2110	2,4,5-TP	515.1	Y	MRL	0.2 UG/L	null
2274	HEXACHLOROBENZENE	505	Y	MRL	0.1 UG/L	null
2274	HEXACHLOROBENZENE	505	Y	MRL	0.1 UG/L	null
2306	BENZO(A)PYRENE	550	Y	MRL	0.02 UG/L	null
2306	BENZO(A)PYRENE	550	Y	MRL	0.02 UG/L	null
2326	PENTACHLOROPHENOL	515.1	Y	MRL	0.04 UG/L	null
2326	PENTACHLOROPHENOL	515.1	Y	MRL	0.04 UG/L	null
2378	1,2,4-TRICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2378	1,2,4-TRICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2380	CIS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2380	CIS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2383	TOTAL POLYCHLORINATED BIPHENYLS (PCB)	505	Y	MRL	0.1 UG/L	null
2383	TOTAL POLYCHLORINATED BIPHENYLS (PCB)	505	Y	MRL	0.1 UG/L	null
2931	1,2-DIBROMO-3-CHLOROPROPANE	504.1	Y	MRL	0.02 UG/L	null
2931	1,2-DIBROMO-3-CHLOROPROPANE	504.1	Y	MRL	0.02 UG/L	null
2946	ETHYLENE DIBROMIDE	504.1	Y	MRL	0.01 UG/L	null
2946	ETHYLENE DIBROMIDE	504.1	Y	MRL	0.01 UG/L	null

2955	XYLENES, TOTAL	524.2	Y	MRL	0.5 UG/L	null
2955	XYLENES, TOTAL	524.2	Y	MRL	0.5 UG/L	null
2959	CHLORDANE	505	Y	MRL	0.01 UG/L	null
2959	CHLORDANE	505	Y	MRL	0.01 UG/L	null
2964	DICHLOROMETHANE	524.2	Y	MRL	0.5 UG/L	null
2964	DICHLOROMETHANE	524.2	Y	MRL	0.5 UG/L	null
2968	O-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2968	O-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2969	P-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2969	P-DICHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2976	VINYL CHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2976	VINYL CHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2977	1,1-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2977	1,1-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2979	TRANS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2979	TRANS-1,2-DICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2980	1,2-DICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2980	1,2-DICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2981	1,1,1-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2981	1,1,1-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2982	CARBON TETRACHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2982	CARBON TETRACHLORIDE	524.2	Y	MRL	0.5 UG/L	null
2983	1,2-DICHLOROPROPANE	524.2	Y	MRL	0.5 UG/L	null
2983	1,2-DICHLOROPROPANE	524.2	Y	MRL	0.5 UG/L	null
2984	TRICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2984	TRICHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2985	1,1,2-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2985	1,1,2-TRICHLOROETHANE	524.2	Y	MRL	0.5 UG/L	null
2987	TETRACHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null
2987	TETRACHLOROETHYLENE	524.2	Y	MRL	0.5 UG/L	null

2989	CHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2989	CHLOROBENZENE	524.2	Y	MRL	0.5 UG/L	null
2990	BENZENE	524.2	Y	MRL	0.5 UG/L	null
2990	BENZENE	524.2	Y	MRL	0.5 UG/L	null
2991	TOLUENE	524.2	Y	MRL	0.5 UG/L	null
2991	TOLUENE	524.2	Y	MRL	0.5 UG/L	null
2992	ETHYLBENZENE	524.2	Y	MRL	0.5 UG/L	null
2992	ETHYLBENZENE	524.2	Y	MRL	0.5 UG/L	null
2996	STYRENE	524.2	Y	MRL	0.5 UG/L	null
2996	STYRENE	524.2	Y	MRL	0.5 UG/L	null

Total Number of Records Fetched = 121

REFERENCES

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Coliform Sample Summary Results

Lead And Copper Sample Summary Results

Non-Coliform Samples/Results

Non-Coliform Samples/Results by Analyte

Violations/Enforcement Actions

Site Visits

Milestones

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Water System Details

Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
CHAVEZ, BEN	null	OP	505-287-7124	PO BOX 2727, MILAN, NM-87021	Not Available
CHAVEZ, BEN	null	AC	505-287-7124	PO BOX 2727, MILAN, NM-87021	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	1911

Service Connections

Type	Count
CB	1043

Sources of Water

Name	Type Code	Status
WELL #1 (B-23)	WL	A
WELL #2 (B-24)	WL	I
WELL #3 (B-35)	WL	A
WELL # 4 (GOLDEN ACRES B-50)	WL	A

Service Areas

Code	Name
R	RESIDENTIAL AREA

Water Purchases

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC200200323	**Collection Date :**	07-10-2002

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.1 PCI/L	7.2 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.1 PCI/L	7.2 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.05 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.05 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1 PCI/L	4.7 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1 PCI/L	4.7 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC20020285	**Collection Date :**	06-18-2002

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		0.9 PCI/L	4 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		0.9 PCI/L	4 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.04 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.04 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.1 PCI/L	3.1 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.1 PCI/L	3.1 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC200000583	**Collection Date :**	06-15-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.8 PCI/L	9.3 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.8 PCI/L	9.3 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.03 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.03 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.6 PCI/L	6.4 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.6 PCI/L	6.4 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC200000585	**Collection Date :**	06-15-2000

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.5 PCI/L	4.6 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.5 PCI/L	4.6 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.05 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.05 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.5 PCI/L	5.5 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.5 PCI/L	5.5 PCI/L		

Total Number of Records Fetched = 6

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC980131	**Collection Date :**	03-23-1998

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4006	COMBINED URANIUM	null	N		0.7 PCI/L	7 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		

Total Number of Records Fetched = 7

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Glossary

Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC980131	**Collection Date :**	12-23-1997

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4006	COMBINED URANIUM	null	N		0.7 PCI/L	7 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		

Total Number of Records Fetched = 7

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC980131	**Collection Date :**	09-23-1997

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4006	COMBINED URANIUM	null	N		0.7 PCI/L	7 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		

Total Number of Records Fetched = 7

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC980131	**Collection Date :**	06-23-1997

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4006	COMBINED URANIUM	null	N		0.7 PCI/L	7 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		

Total Number of Records Fetched = 7

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC199600297	**Collection Date :**	06-19-1996

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		0.9 PCI/L	5.5 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		0.9 PCI/L	5.5 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.06 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.06 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.3 PCI/L	2.8 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.3 PCI/L	2.8 PCI/L		

Total Number of Records Fetched = 6

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Non-Coliform Sample Results

Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC960292	**Collection Date :**	06-19-1996

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.3 PCI/L	10.8 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.3 PCI/L	10.8 PCI/L		
4006	COMBINED URANIUM	null	N		0.7 PCI/L	8.4 PCI/L		
4007	URANIUM-234	null	N		0.08 PCI/L	6.26 PCI/L		
4009	URANIUM-238	null	N		0.08 PCI/L	3.69 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.05 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.05 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.6 PCI/L	4.7 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		2.6 PCI/L	4.7 PCI/L		

Total Number of Records Fetched = 9

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Water System No. :	NM3525533	**Federal Type :**	C
Water System Name :	MILAN COMMUNITY WATER SYSTEM	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977
Lab Sample No. :	RC980131	**Collection Date :**	null

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.1 PCI/L	9.9 PCI/L		
4006	COMBINED URANIUM	null	N		0.7 PCI/L	7 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.14 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.9 PCI/L	10.6 PCI/L		

Total Number of Records Fetched = 7

Drinking Water Bureau

Links

Water System Facilities

Sample Schedules

Coliform Sample Results

Coliform Sample Summary Results

Lead And Copper Sample Summary R ts

Non-Coliform Samples/Results

Non-Coliform Samples/Results by Analyte

Violations/Enforcement Actions

Site Visits

Milestones

Return Links

Water Systems

Water System Search

C unty Map

Glossary

Water System Details

Water System No. :	NM3525133	**Federal Type :**	C
Water System Name :	GOLDEN ACRES TRAILER PARK	**State Type :**	C
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	I	**Activity Date :**	06-15-1995

Points of Contact

Name	Job Title	Type	Phone	Address	Email
MOORE, BOB	null	OP	505-287-8789	2501 W. HWY 66, GRANTS, NM-87020	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	81

Service Connections

Type	Count
CB	23

Sources of Water

Name	Type Code	Status
WELL # 1	WL	I

Service Areas

Code	Name
R	MOBILE HOME PARK

Water Purchases

Seller Water System No.	Water System Name	Seller Water Type	Purchase Date	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

Drinking Water Bureau

Links

Water System Facilities

Sample Schedules

Coliform Sample Results

Coliform Sample Summary Results

Lead And Copper Sample Summary Results

Non-Coliform Samples/Results

Non-Coliform Samples/Results by Analyte

Violations/Enforcement Actions

Site Visits

Milestones

Return Links

Water Systems

Water System Search

County Map

Glossary

Water System Details

Water System No. :	NM3597233	Federal Type :	NTNC
Water System Name :	MOUNT TAYLOR MILLWORKS	State Type :	NTNC
Principal County Served :	CIBOLA	Primary Source :	GW
Status :	A	Activity Date :	01-01-1976

Points of Contact

Name	Job Title	Type	Phone	Address	Email
ALLEN, HARDY	null	AC	505-287-9469	PO Box 2307, MILAN, NM-87021	Not Available
ALLEN, PAT	null	OW	505-287-9469	PO Box 2307, MILAN, NM-87021	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	NT	65

Service Connections

Type	Count
CB	1

Sources of Water

Name	Type Code	Status
WELL # 1	WL	A

Service Areas

Code	Name
NT	INDUSTRIAL/AGRICULTURAL

Water Purchases

Seller Water System No.	Water System Name	Seller Water Type	Purchase Date	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

31

Drinking Water Bureau

Non-Coliform Sample Results

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Non-Coliform
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Analyte List

Water System
etail

Water Systems

Water System
earch

County Map

lossary

Water System No. :	NM3597233	**Federal Type :**	NTNC
Water System Name :	MOUNT TAYLOR MILLWORKS	**State Type :**	NTNC
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	01-01-1976
Lab Sample No. :	RC200700154	**Collection Date :**	04-19-2007

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitori Period E Date
4000	GROSS ALPHA, EXCL. RADON & U	900	N		2.5 PCI/L	6.6 PCI/L	01-01-2004	12-31-20(
4000	GROSS ALPHA, EXCL. RADON & U	900	N		2.5 PCI/L	6.6 PCI/L	01-01-2004	12-31-20(
4006	COMBINED URANIUM	200.8	N		1 UG/L	11. UG/L	01-01-2004	12-31-20(
4010	COMBINED RADIUM (-226 & -228)	null	null		null null	0.23 PCI/L		
4010	COMBINED RADIUM (-226 & -228)	null	null		null null	0.23 PCI/L		
4020	RADIUM-226	903.1	N		0.01 PCI/L	0.09 PCI/L	01-01-2004	12-31-20(
4020	RADIUM-226	903.1	N		0.01 PCI/L	0.09 PCI/L	01-01-2004	12-31-20(
4030	RADIUM-228	904.0	N		0.19 PCI/L	0.14 PCI/L	01-01-2004	12-31-20(
4030	RADIUM-228	904.0	N		0.19 PCI/L	0.14 PCI/L	01-01-2004	12-31-20(
4100	GROSS BETA PARTICLE ACTIVITY	900	N		1.9 PCI/L	10.7 PCI/L	01-01-2004	12-31-20(
4100	GROSS BETA PARTICLE ACTIVITY	900	N		1.9 PCI/L	10.7 PCI/L	01-01-2004	12-31-20(

Drinking Water Bureau

Non-Coliform Sample Results

Return Links

Non-Coliform Samples

Analyte List

Water System Detail

Water Systems

Water System Search

County Map

Glossary

Water System No. :	NM3597233	**Federal Type :**	NTNC
Water System Name :	MOUNT TAYLOR MILLWORKS	**State Type :**	NTNC
Principal County Served :	CIBOLA	**Primary Source :**	GW
Status :	A	**Activity Date :**	01-01-1976
Lab Sample No. :	RC200200319	**Collection Date :**	07-09-2002

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorin Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.7 PCI/L	10.5 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		1.7 PCI/L	10.5 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.08 PCI/L		
4020	RADIUM-226	null	N		0.02 PCI/L	.08 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.4 PCI/L	5.8 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.4 PCI/L	5.8 PCI/L		

Total Number of Records Fetched = 6

Drinking Water Bureau

Non-Coliform Sample Results

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Non-Coliform
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Analyte List

Water System
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Water Systems

Water System
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County Map

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Water System No. :	NM3597233	Federal Type :	NTNC
Water System Name :	MOUNT TAYLOR MILLWORKS	State Type :	NTNC
Principal County Served :	CIBOLA	Primary Source :	GW
Status :	A	Activity Date :	01-01-1976
Lab Sample No. :	RC200100657	Collection Date :	09-18-2001

Analyte Code	Analyte Name	Method Code	Less than Indicator	Level Type	Reporting Level	Concentration level	Monitoring Period Begin Date	Monitorir Period En Date
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.6 PCI/L	2.8 PCI/L		
4000	GROSS ALPHA, EXCL. RADON & U	null	N		2.6 PCI/L	2.8 PCI/L		
4020	RADIUM-226	null	Y	MRL	0.02 PCI/L	null		
4020	RADIUM-226	null	Y	MRL	0.02 PCI/L	null		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.7 PCI/L	7.1 PCI/L		
4100	GROSS BETA PARTICLE ACTIVITY	null	N		1.7 PCI/L	7.1 PCI/L		

Total Number of Records Fetched = 6

Mayerson, David, NMENV

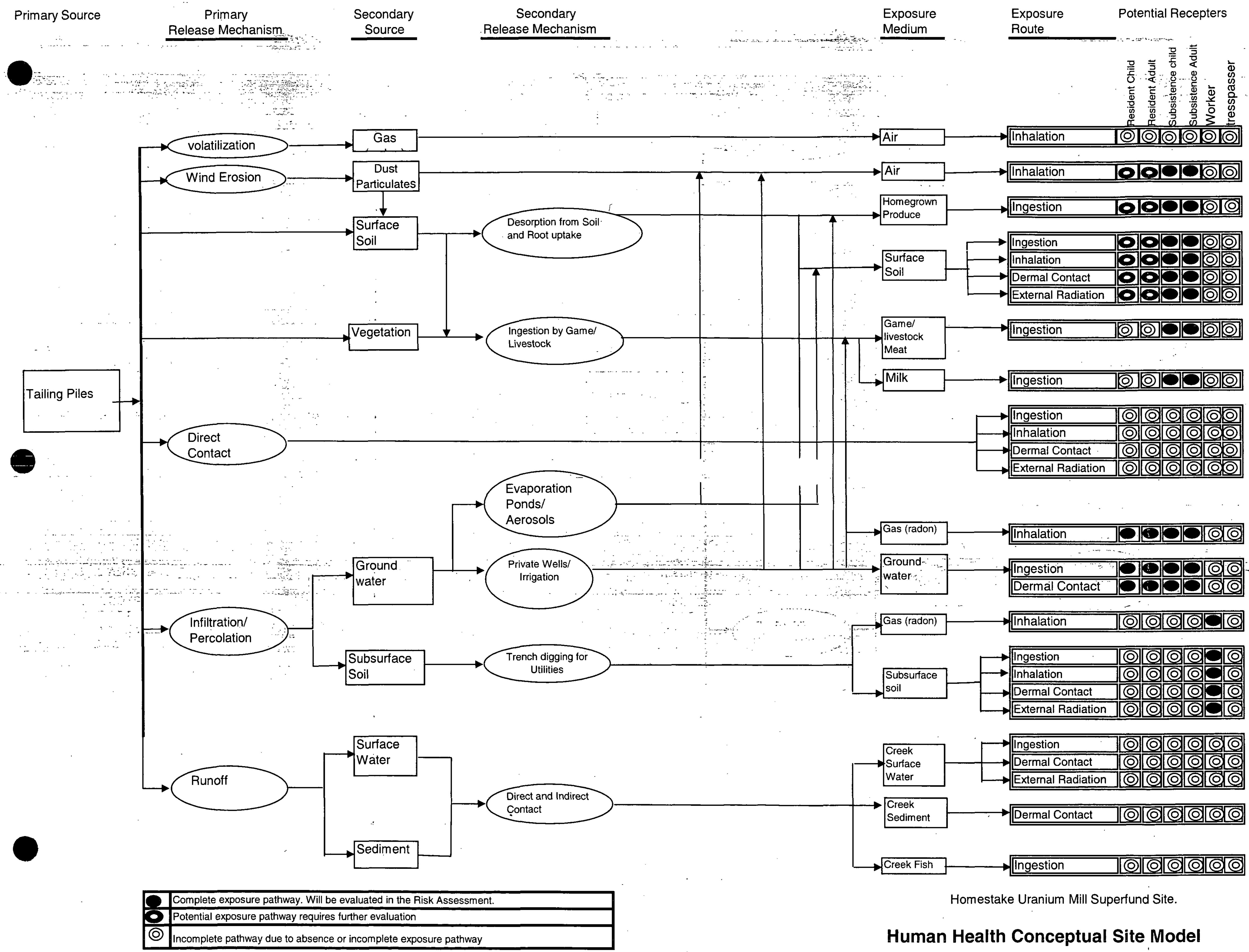
From:	Appaji.Sairam@epamail.epa.gov
Sent:	Thursday, January 17, 2008 06:57
To:	Mayerson, David, NMENV; Schoeppner, Jerry, NMENV
Cc:	Bahar, Dana, NMENV
Subject:	CSM for HMC
Attachments:	Human Health Conceptual Site Model.xls

Human Health Conceptual Site M...

Attached is a draft CSM developed by Ghassan Khoury, Senior Risk Assessor. Please review and let me know if you have any questions. I can arrange a conference call if you would like to discuss this. The next step in the process is for the risk assessor to review available data and identify data gaps.

(See attached file: Human Health Conceptual Site Model.xls)

Sai Appaji
Remedial Project Manager
USEPA Region 6, Superfund Division
Dallas, TX 75202
Tel: 214-665-3126



Homestake Uranium Mill Superfund Site.

Human Health Conceptual Site Model

REFERENCES

53-56

```
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: As needed

  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -109.05088043
      East_Bounding_Coordinate: -102.99900818
      North_Bounding_Coordinate: 37.00014496
      South_Bounding_Coordinate: 31.33181763

  Keywords:
    Theme:
      Theme_Keyword_Thesaurus: none
      Theme_Keyword: New Mexico Roads, Interstates, US Highways, NM Highways, County
Roads, Streets
    Place:
      Place_Keyword_Thesaurus: none
      Place_Keyword: The State of New Mexico

  Access_Constraints: None

  Use_Constraints:
    Resource Geographic Information System (RGIS) Program assumes no
    liability for misuse of the data. Data should be used at the scale
    for which they were intended.  No warranty, expressed, or implied, is
    made by Earth Data Analysis Center (EDAC) regarding the utility of
    the data on any other system, nor shall the act of distribution
    constitute such warranty.

  Point_of_Contact:
    Contact_Information:
      Contact_Person_Primary:
        Contact_Organization: Earth Data Analysis Center
      Contact_Position: RGIS Clearinghouse Coordinator
      Contact_Address:
        Address_Type: mailing address
        Address: University of New Mexico, Bandelier West Room 111
        City: Albuquerque
        State_or_Province: New Mexico
        Postal_Code: 87131-6031
        Country: USA
      Contact_Voice_Telephone: 505-277-3622
      Contact_Facsimile_Telephone: 505-277-3614
      Contact_Electronic_Mail_Address: edac@edac.unm.edu
      Hours_of_Service: 8:00-5:00 Mountain Time Zone
  Browse_Graphic
    Browse_Graphic_File_Name:  http://rgisedac.unm.edu/previews/tra0005.jpg
    Browse_Graphic_File_Description:  Simple image of the data set and/or its
    extent.
    Browse_Graphic_File_Type:  jpg
  Native_Data_Set_Environment:
    OSF1, V4.0, alpha UNIX
    ARC/INFO version 7.2.1

Data_Quality_Information:
  Logical_Consistency_Report:
    Chain-node topology present.
    Tolerances were chosen to prevent errors in labels,
    intersections, tics, overshoots, and undershoots. Tests
    were performed to detect these types of errors and necessary
    corrections were made.
```

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Earth Data Analysis Center
      Publication_Date: 19951201
      Title: New Mexico GPS Roads
      Edition: First
      Geospatial_Data_Presentation_Form: map
      Publication_Information:
        Publication_Place: Albuquerque
        Publisher: Earth Data Analysis Center
      Other_Citation_Details:
      Online_Linkage: http://rgis.unm.edu/rgisftp.htm
      Online_Linkage: http://rgisedac.unm.edu/transport/gpsrdsdde00.zip
      Online_Linkage: http://rgisedac.unm.edu/transport/gpsrdsddshp.zip

  Description:
    Abstract:
      This data set contains a 1:100,000 scale vector digital representation of all interstate highways, all US highways, most of the state highways, and some county roads in New Mexico.
      The data were collected using Trimble Pathfinder Basic Plus GPS units and differentially corrected with Trimble Pfinder software, version 2.40-07.
      They were converted to ARC/INFO format using ARC/INFO 7.0.3.
      The file size is approximately 4.2 Mb, compressed.

    Purpose:
      These data are typically used as base data for other coverages. The data are intended for use as a general reference to the extent and location of Highways and Interstates in New Mexico.

    Supplemental_Information:
      Procedures_Used:
      The data were collected using Trimble Pathfinder Basic Plus GPS units.
      The data were differentially corrected using Base Station Files in the Pfinder software program. The files were converted to ARC/INFO format and then imported into ARC/INFO and turned into a coverage and attributed with the name information.

      Revisions:
      None to data.
      Item called TYPE added Nov. 2002 to delineate Interstate, US Highway, State Highway, or Local road.

      Reviews_Applied_to_Data:
      None

      Related_Spatial_and_Tabular_Data_Sets:
      none

      Other_References_Cited:
      none

      Notes:
      Contact the RGIS Clearinghouse for price information.
      http://rgis.unm.edu

  Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19951201
    Currentness_Reference: Publication Date

```
further makes no warranties, either expressed or implied as to any other matter
whatsoever, including, without limitation, the condition of the product, or its
fitness for any particular purpose. The burden for determining fitness for use
lies entirely with the user. Although these data have been processed
successfully
on computers of RGIS, no warranty, expressed or implied, is made by RGIS
regarding
the use of these data on any other system, nor does the fact of distribution
constitute or imply any such warranty. In no event shall RGIS have any liability

whatsoever for payment of any consequential, incidental, indirect, special, or
tort
damages of any kind, including, but not limited to, any loss of profits arising
out of use of or reliance on the geographic data or arising out of the delivery,

installation, operation, or support by RGIS.

Standard_Order_Process:
  Digital_Form:
    Digital_Transfer_Information:
      Format_Name: ArcExport
      Format_Version_Number: 8.0.1
      Format_Version_Date:
    Digital_Transfer_Option:
      Online_Option:
        Computer_Contact_Information:
          Network_Address:
            Network_Resource_Name: http://rgis.unm.edu/rgisftp.htm
  Digital_Form:
    Digital_Transfer_Information:
      Format_Name: Arc shape file
      Format_Version_Number: 8.0.1
      Format_Version_Date:
    Digital_Transfer_Option:
      Online_Option:
        Computer_Contact_Information:
          Network_Address:
            Network_Resource_Name: http://rgis.unm.edu/rgisftp.htm

Metadata_Reference_Information:
  Metadata_Date: 19980127
  Metadata_Review_Date: 19980127
  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: Earth Data Analysis Center
      Contact_Position: Geographic Data Services Manager
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 111 Bandelier West, University of New Mexico
        City: Albuquerque
        State_or_Province: NM
        Postal_Code: 87131-6031
        Country: USA
      Contact_Voice_Telephone: 505-277-3622
      Contact_Facsimile_Telephone: 505-277-3614
      Contact_Electronic_Mail_Address: edac@edac.unm.edu
  Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
  Metadata_Standard_Version: Version of June 8, 1994
```

```
  Completeness_Report: Data completeness reflects the content of the source file.

  Positional_Accuracy:
    Horizontal_Positional_Accuracy:
      Horizontal_Positional_Accuracy_Report:
        The root-mean square error is generally .003 map units
        or less.

  Lineage:
    Process_Step:
      Process_Description: NOREEN DOCUMENT TRA0005
      Process_Date: 19951201

Spatial_Data_Organization_Information:
  Direct_Spatial_Reference_Method: Vector
  Point_and_Vector_Object_Information:
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: String
      Point_and_Vector_Object_Count: 11299

Spatial_Reference_Information:
  Horizontal_Coordinate_System_Definition:
    Geographic:
      Latitude_Resolution: 0.001
      Longitude_Resolution: 0.001
      Geographic_Coordinate_Units: Decimal Degrees
    Geodetic_Model:
      Horizontal_Datum_Name: North American Datum of 1983
      Ellipsoid_Name: Geodetic Reference System 80
      Semi-major_Axis: 6,378,137
      Denominator_of_Flattening_Ratio: 298.257

Entity_and_Attribute_Information:
  Overview_Description:
    Entity_and_Attribute_Overview:
      There are two attributes, Name and Alt_name. The names were provided
      by the New Mexico State Highway and Transportation Department (NMSHTD).
      Name is the primary road name and Alt_name contains the secondary
      road name or the NMSHTD route designation, i.e. interstate, federally
      aided local, business loop, frontage, state highway, or county road.
    Entity_and_Attribute_Detail_Citation: none

Distribution_Information:
  Distributor:
    Contact_Information:
      Contact_Person_Primary:
        Contact_Organization: Earth Data Analysis Center
      Contact_Position: Geographic Data Services Manager
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 111 Bandelier West, University of New Mexico
        City: Albuquerque
        State_or_Province: New Mexico
        Postal_Code: your 87131-6031
        Country: USA
      Contact_Voice_Telephone: 505-277-3622
      Contact_Facsimile_Telephone: 505-277-3614
      Contact_Electronic_Mail_Address: edac@edac.unm.edu
      Hours_of_Service: 8AM - 5PM Mountain Time

  Distribution_Liability:
    RGIS provides these geographic data "as is" and makes no guarantee or warranty
    concerning the accuracy of information contained in the geographic data. RGIS
```

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Earth Data Analysis Center
      Publication_Date: 19950501
      Publication_Time:
      Title: Cities and towns
      Edition:
      Geospatial_Data_Presentation_Form: map
        Series_Name:
        Issue_Identification:
      Publication_Information:
        Publication_Place: Albuquerque
        Publisher: RGIS
      Other_Citation_Details:
      Online_Linkage:

  Description:
    Abstract:
     This data set contains points for 1600 populated places, cities and towns, in New Mexico. The points were generated from latitude and longitude coordinates contained in the GNIS file, and therefore, do not have a known scale.

    Purpose:
     This data set was created to show the locations of towns in New Mexico mainly as a reference background to other geographic features.

    Supplemental_Information:

      Procedures_Used:
      A completed dBASE III file of New Mexico place names was obtained from the local GNIS contractor. Coordinates for longitude and latitude were extracted from that file. They are in the format nnnnnnNnnnnnnnW. A C program was written to remove the N and W; insert spaces between the degrees, minutes, and seconds as well as between the 2 coordinates; and reverse the order so that longitude was first. Next, points were created in ARC/INFO 7.0.3 with the generate command. Then the point file was joined back to the GNIS file attributes. From the GNIS Web Site a text file of population, elevation, and 7.5 minute topographic quad map name was obtained. Using the GNIS ID, this new data was attached to the point data set.

      Revisions:
      This data set has been revised once to correct points for which the original geographic coordinates were incorrect.

      Reviews_Applied_to_Data:
      Points were checked for accurate locations by drawing them against a background of county boundaries and comparing county names of the two files for matching.

      Related_Spatial_and_Tabular_Data_Sets:
      Fpn0003 Features and Place Names for populated and historic towns, etc.

      Other_References_Cited:

```
Notes:
data sets.

Time_Period_of_Content:
 Time_Period_Information:
  Single_Date/Time:
    Calendar_Date: 19950501
 Currentness_Reference:

Status:
  Progress:  Complete
  Maintenance_and_Update_Frequency:

Spatial_Domain:
  Bounding_Coordinates:
    West_Bounding_Coordinate: -109.04055786
    East_Bounding_Coordinate: -103.04165649
    North_Bounding_Coordinate: 36.99861145
    South_Bounding_Coordinate: 31.33388901
Keywords:
  Theme:
    Theme_Keyword_Thesaurus:  None
    Theme_Keyword:  cities
  Place:
    Place_Keyword_Thesaurus:  None
    Place_Keyword:  State of New Mexico
  Stratum:
    Stratum_Keyword_Thesaurus:  None
    Stratum_Keyword: None
  Temporal:
    Temporal_Keyword_Thesaurus:  None
    Temporal_Keyword: None
Access_Constraints:

Use_Constraints:
 The coordinates from which the points were derived were determined manually
 from paper 7.5 minute map sheets. The points are only as accurate as
 the original manual locating process allows.

Point_of_Contact:
 Contact_Information:
  Contact_Person_Primary:
    Contact_Person: Amy Budge
    Contact_Organization: Earth Data Analysis Center
  Contact_Position: Geographic Data Services Manager
  Contact_Address:
    Address_Type: mailing address
    Address: 118 Bandelier West, University of New Mexico
    City: Albuquerque
    State_or_Province: New Mexico
    Postal_Code: 87131
    Country: USA
  Contact_Voice_Telephone: 505-277-3622 x231
  Contact_TDD/TTY_Telephone: none
  Contact_Facsimile_Telephone: 505-277-3614
  Contact_Electronic_Mail_Address: edac@spock.unm.edu
```

```
  Hours_of_Service: 8:00 AM to 5:00 PM, Mountain Time Zone
Data_Set_Credit:

Security_Information:
  Security_Classification_System: None
  Security_Classification:  Unclassified
  Security_Handling_Description: None
Native_Data_Set_Environment: OSF1, V4.0, alpha UNIX, ARC/INFO version 7.1.1
Cross_Reference:
 Citation_Information:
  Originator: Julyan, Bob and U.S.G.S. Goegraphic Names Information System
  Publication_Date: 1995
  Publication_Time:
  Title: Goegraphic Names of New Mexico
  Edition:
  Geospatial_Data_Presentation_Form: dBase file
  Series_Information:
    Series_Name:
    Issue_Identification:
  Publication_Information:
    Publication_Place: unknown
    Publisher: U.S. Geological Survey
  Other_Citation_Details:
  Online_Linkage:

Data_Quality_Information:
 Attribute_Accuracy:
  Attribute_Accuracy_Report:  See Entity_Attribute_Information
  Quantitative_Attribute_Accuracy_Assessment:
    Attribute_Accuracy_Value:  See Explanation
    Attribute_Accuracy_Explanation:
      Attribute accuracy is described, where present, with each
      attribute defined in the Entity and Attribute Section.
 Logical_Consistency_Report:  Point features present.
 Completeness_Report:

 Positional_Accuracy:
  Horizontal_Positional_Accuracy:
    Horizontal_Positional_Accuracy_Report:

  Vertical_Positional_Accuracy:
    Vertical_Positional_Accuracy_Report:

 Lineage: See also Supplemental_Information:
  Source_Information:
   Source_Citation:
    Citation_Information:
     Originator:
     Publication_Date:
     Title:
   Source_Scale_Denominator:
   Type_Of_Source_Media:
   Source_Time_Period_of_Content:
     Time_Period_Information:
      Single_Date/Time:
       Calendar_Date:
     Source_Currentness_Reference:
```

```
    Source_Citation_Abbreviation:
    Source_Contribution:
  Cloud_Cover:

Spatial_Data_Organization_Information:
  Direct_Spatial_Reference_Method:  Point
  Point_and_Vector_Object_Information:
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type:  Point
      Point_and_Vector_Object_Count:  1600
      SDTS_Point_and_Vector_Object_Type:  String
      Point_and_Vector_Object_Count:  0
      SDTS_Point_and_Vector_Object_Type:  GT-polygon composed of chains
      Point_and_Vector_Object_Count:  0

Spatial_Reference_Information:
  Horizontal_Coordinate_System_Definition:
    Geographic
      Latitude_Resolution:
      Longitude_Resolution:
      Geographic_Coordinate_Units:  Decimal Degrees
    Geodetic_Model:
      Horizontal_Datum_Name: Unknown
      Ellipsoid_Name:  Clarke 1866
      Semi-major_Axis: 6378206.4
      Denominator_of_Flattening_Ratio: 294.98

Entity_and_Attribute_Information:
  Detailed_Description:
    Entity_Type:
      Entity_Type_Label:  CIT0004.PAT
      Entity_Type_Definition:  Point Attribute Table
      Entity_Type_Definition_Source:  ARC/INFO
    Attribute:
      Attribute_Label:  -
      Attribute_Definition:  Point Attribute Table
      Attribute_Definition_Source:  ARC/INFO
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value:  -
          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
    Attribute:
      Attribute_Label:  AREA
      Attribute_Definition:  Degenerate area of point
      Attribute_Definition_Source:  Assigned
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value:  0
          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
    Attribute:
      Attribute_Label:  PERIMETER
      Attribute_Definition:  Degenerate perimeter of point
      Attribute_Definition_Source:  Assigned
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value:  0
          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
    Attribute:
      Attribute_Label:  CIT0004#
      Attribute_Definition:  Internal feature number
```

```
      Attribute_Definition_Source:  Computed
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value:  Sequential unique positive integer
          Enumerated_Domain_Value_Definition:
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          Enumerated_Domain_Value_Definition_Source:
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      Attribute_Definition:  Name of city
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      Attribute_Domain_Values:
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          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
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      Attribute_Definition:  Type of feature
      Attribute_Definition_Source:
      Attribute_Domain_Values:
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          Enumerated_Domain_Value:  ppl = populated place
          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
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      Attribute_Label:  CNTY
      Attribute_Definition:  County wherein city is located
      Attribute_Definition_Source:
      Attribute_Domain_Values:
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          Enumerated_Domain_Value:
          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
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      Attribute_Domain_Values:
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          Enumerated_Domain_Value_Definition:
          Enumerated_Domain_Value_Definition_Source:
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      Attribute_Definition:  Elevation of city, in feet
```

Attribute_Definition_Source:
Attribute_Domain_Values:
Enumerated_Domain:
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Enumerated_Domain_Value_Definition:
Enumerated_Domain_Value_Definition_Source:
Attribute:
Attribute_Label: TOPOMAP
Attribute_Definition: Name of 7.5 minute quad map on which city is located
Attribute_Definition_Source:
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value:
Enumerated_Domain_Value_Definition:
Enumerated_Domain_Value_Definition_Source:
Attribute:
Attribute_Label: POP
Attribute_Definition: Population of city (only availble for larger places)
Attribute_Definition_Source:
Attribute_Domain_Values:
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Overview_Description:
Entity_and_Attribute_Overview:
The num, name, feature, cnty, and coord fields were taken from the original GNIS file for New Mexico. Elevatn, topomap, and pop were attached later from files obtained from the Board of Geographic names Web site.

Entity_and_Attribute_Detail_Citation: Not Available

Distribution_Information:
Distribution_Liability: RGIS program assumes no liability for misuse of the data
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: ARCE ARC/INFO Export format
Format_Version_Number: 7.1.1
Format_Version_Date: n/a
Format_Specification: n/a
Format_Information_Content: n/a
File_Decompression_Technique: Compressed
Digital_Transfer_Option:
Offline_Option:
Offline_Media: CDROM, 3.5" disk, 4mm tape, 8mm tape, .25" tape
Recording_Format: low, medium, or high density
Fees: Most files $45.00 plus $25.00 media charge
Ordering_Instructions: RGIS Clearinghouse, Earth Data Analysis Center
Turnaround: Variable, usually within 10 working days

Custom_Order_Process: Guest account option for ftp access.
Technical_Prerequisites: Hardware and software compatible with Arc Export or ArcView.
Available_Time_Period:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: Present
Ending_Date: Unknown

Metadata_Reference_Information:
Metadata_Date: 19980223

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Metadata_Contact:
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  Contact_Person_Primary:
    Contact_Person: Amy Budge
    Contact_Organization: Earth Data Analysis Center
  Contact_Position: Geographic Data Services Manager
  Contact_Address:
    Address_Type: mailing address
    Address: 118 Bandelier West, University of New Mexico
    City: Albuquerque
    State_or_Province: New Mexico
    Postal_Code: 87131
    Country: USA
  Contact_Voice_Telephone: 505-277-3622 x231
  Contact_TDD/TTY_Telephone: none
  Contact_Facsimile_Telephone: 505-277-3614
  Contact_Electronic_Mail_Address: edac@spock.unm.edu
  Hours_of_Service: 8:00 AM to 5:00 PM, Mountain Time Zone

Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
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Mayerson, David, NMENV

From: Mayerson, David, NMENV
Sent: Wednesday, January 09, 2008 11:49
To: Arfman, Suzan, NMENV
Subject: Categorization of minesites for map presentation

Suzan: As we had discussed yesterday, could you see if you could symbolize the minesites by the PRODUCTION and MINING_MET fields. For the PRODUCTION field, some of the sites are categorized by a letter followed by hyphen and "f" (e.g., the Dakota Mine is classified "a-f"); just use the first letter in all cases.

For MINING_MET, just use 3 categories: surface, underground, surface + underground. For the few that have some odd entries, categorize as follows
Open stope=underground
stripping=surface
room and pillar=underground

Hopefully this will cover all the combinations and not make the map too messy.

David L. Mayerson
New Mexico Environment Department
Ground Water Quality Bureau
Superfund Oversight Section
1190 St. Francis Drive, Suite N2312
Santa Fe, NM 87505

Telephone: (505) 476-3777
Fax: (505) 827-2965
david.mayerson@state.nm.us

Mayerson, David, NMENV

From: Mayerson, David, NMENV
Sent: Tuesday, January 15, 2008 13:02
To: Arfman, Suzan, NMENV
Subject: RE: Mines

Now this is starting to look like what I'm after. See comments to previous email regarding Bluewater mill especially.

Can you symbolize the mines so that the shape indicates one of the 3 MINING_MET categories, and the color indicates production?

David L. Mayerson
New Mexico Environment Department
Ground Water Quality Bureau
Superfund Oversight Section
1190 St. Francis Drive, Suite N2312
Santa Fe, NM 87505

Telephone: (505) 476-3777
Fax: (505) 827-2965
david.mayerson@state.nm.us

From: Arfman, Suzan, NMENV
Sent: Tuesday, January 15, 2008 12:50
To: Mayerson, David, NMENV
Subject: Mines

REFERENCES

57-60

Abstract:
The Digital Geologic Map of New Mexico in ARC/INFO Format
by Gregory N. Green and Glenn E. Jones
This geologic map was prepared as part of a study of digital methods and techniques as applied to complex geologic maps. The geologic map was digitized in GSMAP version 8 (Selner and Taylor, 1992) at Socorro, New Mexico by Orin Anderson and Glen Jones and published as the Geologic Map of New Mexico 1:500,000 (Anderson and Jones, 1994) in GSMAP format. The vector line work and polygon point labels were converted to ARC/INFO format on a DOS based PC with GSMARC (Green and Selner,1988). These data were transferred to a Data General UNIX system and loaded into ARC/INFO. Each vector and polygon was given attributes derived from the original 1994 GSMAP geologic map. Both digital versions are at 1:500,000 scale using the Lambert Conformal Conic map projection parameters of the State base map. The coverage was projected into Geographic NAD27 August 2000, and reprojected into Geographic NAD83 in August 2001.

Purpose:
Applications that use this data
    models and assesments
Intended use of data
    base geologic map

Limitations_of_Data:
Scale is 1:500,000 and should not be used outside that range

In order to use this database, ARC/INFO software and hardware and FTP transfer software to copy the database to the ARC/INFO platform are required. Published geologic maps are prepared using a USGS topographic base map that contains the hydrology, hypsography, and political features. Because this digital version of the Geologic Map of New Mexico started as a geologic map, these features were not present. Only those water bodies that were required to close polygons were added. The digital hydrology is not complete or as accurate as the original USGS 1:500,000 topographic base. A few water bodies were added for visual effect. No roads, contours, or towns were present on the GSMAP version of the geologic map and none were added to this ARC/INFO version.

Entity_and_Attribute_Overview:
CODING SCHEME FOR ARC ATTRIBUTES:

ITEM	FEATURE
P1	GSMAP Shorthand attribute
HP	Line pattern from NMLIN.LIN
NAME	Name

Line Types and Attributes

P1	HP	Name
1	1	contact
2	501	Ti dikes
5	102	solid faults
6	102	thrust faults
8	114	dashed fault
9	1	group to specific (lump grouping)
11	106	dotted faults
12	507	Yi dikes
21	127	Map Border
22	505	TKi dikes
32	503	Tli dikes

45	13	Tla
46	68	Turf
47	7	Tlrf
48	26	Ti
49	54	Tui
50	57	Tuim
51	73	Tli
52	45	Tps
53	90	Tsj
54	91	Tn
55	92	Toa
56	102	Tpc
57	109	TKr
58	107	TKpr
59	93	TKa
60	261	TKav
61	267	TKi
62	238	K
64	255	Ki
65	221	Ka
66	239	Ku
67	236	Kmc
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69	79	Kkf
70	81	Kpc
71	82	Kls
72	208	Kpn
73	233	Knf
74	231	Kmv
75	123	Kch
76	129	Klv
77	124	Kmf
78	225	Kpl
79	170	Kms
80	219	Kph
81	242	Kmm
82	197	Kcc
83	223	Kg
84	226	Kmg
85	169	Kmr
86	227	Kpg
87	191	Kth
88	232	Kma
89	78	Km
90	171	Kmu
91	241	Kml
92	186	Kdr
93	80	Kdm
94	166	Kd
95	229	Kc
96	187	Kgg
97	237	Kgh
98	192	Kgr
99	165	Kdg
100	164	Kbm
101	163	Kl
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104	148	Jmsu
105	151	Jz
106	150	Jze
107	149	Je
108	144	Jsr

178	1	Qa/QTsf
184	2	Ql/QTs
189	8	Qp/QTs
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194	3	Qe/Qp
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199	224	Kgc
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201	36	ds
202	137	Xmu
203	218	Qoa/To
400	216	Water
401	216	Playa
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Procedures_Used:
This geologic map was prepared as part of a study of digital methods and techniques as applied to complex geologic maps. The geologic map was digitized in GSMAP version 8 (Selner and Taylor, 1992) at Socorro, New Mexico by Orin Anderson and Glen Jones and published as the Geologic Map of New Mexico 1:500,000 (Anderson and Jones, 1994) in GSMAP format. The vector line work and polygon point labels were converted to ARC/INFO format on a DOS based PC with GSMARC (Green and Selner,1988). These data were transferred to a Data General UNIX system and loaded into ARC/INFO. Each vector and polygon was given attributes derived from the original 1994 GSMAP geologic map. Both digital versions are at 1:500,000 scale using the Lambert Conformal Conic map projection parameters of the State base map. The coverage was projected into Geographic NAD27 August 2000, and reprojected into Geographic NAD83 in August 2001.

This database was developed on a Data General computer system using DG/UX Release 5.4R3.10 UNIX and ARC/INFO 7.0.3 software. The lineset and shadeset files are coded for a HP 650C plotter.

Revisions:

31 March 1997	Creation date
25 Aug 1997	Last revision to dataset
16 Aug 2000	Projection change from Lambert NAD27 to Geographic NAD27
31 Aug 2001	Datum Change from Geographic NAD27 to Geographic NAD83

Reviews_Applied_to_Data:
For the digital review, we thank Nancy Shock and Pat Stamile of the USGS.

Related_Spatial_and_Tabular_Data_Sets:

0READ.ME	Text file that contains this Open-File 97-52 document.
0READ.MET	A text version of the ARC DOCUMENT metafile.
LOAD.AML	ARC/INFO commands to create the data bases.
NNMAP.AML	ARCPLOT commands that create a plot file of the geologic map from the data bases.
NMMAP.E00	Contacts, dikes and faults file for the Geologic Map of New Mexico.
NMAP1.TXT	Text files for the Geologic Map

Currentness_Reference:
none planned
Maintenance_and_Update_Frequency:
none planned

Access_Constraints:
no restrictions apply

Data_Set_Credit:
U.S. Geological Survey
New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico
Completeness_Report:
The digital hydrology is not complete or as accurate as the original
USGS 1:500,000 topographic base.
Horizontal_Positional_Accuracy_Report:

Vertical_Positional_Accuracy_Report:

Cloud_Cover:

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W.A.T.E.R.S.

Use Codes

Office of the State Engineer
Interstate Stream Commission

Use Code	Use Description
AGR	AGRICULTURE OTHER THAN IRRIGATION
BPW	BRINE PRODUCTION WELL
COM	COMMERCIAL
CON	CONSTRUCTION
CPS	CATHODIC PROTECTION WELL
DAI	DAIRY OPERATION
DCN	DOMESTIC CONSTRUCTION
DEW	DEWATERING WELL
DOL	72-12-1 DOMESTIC AND LIVESTOCK WATERING
DOM	72-12-1 DOMESTIC ONE HOUSEHOLD
EXP	EXPLORATION
FCD	Flood Control
FGP	FISH AND GAME PROPOGATION
FPO	FEED PEN OPERATION
HWY	HIGHWAY CONSTRUCTION
IND	INDUSTRIAL
INJ	INJECTION
IRR	IRRIGATION
MDW	COMMUNITY TYPE USE - MDWCA, PRIVATE OR COMMERCIAL SUPPLIED
MFG	MANUFACTURING
MIL	MILITARY - MILITARY INSTALLATIONS
MIN	MINING OR MILLING OR OIL
MOB	MOBILE HOME PARKS
MON	MONITORING WELL
MPP	MEAT PACKING PLANT
MUL	72-12-1 MULTIPLE DOMESTIC HOUSEHOLDS
MUN	MUNICIPAL - CITY OR COUNTY SUPPLIED WATER
NON	NON-PROFIT ORGANIZATIONAL USE
NOT	NO USE OF RIGHT OR POD
NRT	NO RIGHT.
OBS	OBSERVATION
OFM	OIL FIELD MAINTENANCE
OIL	OIL PRODUCTION
PDL	NON 72-12-1 DOMESTIC & LIVESTOCK
PDM	NON 72-12-1 DOMESTIC
PLS	NON 72-12-1 LIVESTOCK WATERING
PMH	NON 72-12-1 MULTIPLE HOUSEHOLD USE
POL	POLLUTION CONTROL WELL
POU	POULTRY AND EGG OPERATION
PPP	PETROLEUM PROCESSING PLANT
PRO	72-12-1 PROSPECTING OR DEVELOPMENT OF NATURAL RESOURCE
PUB	72-12-1 CONSTRUCTION OF PUBLIC WORKS
REC	RECREATION
SAN	72-12-1 SANITARY IN CONJUNCTION WITH A COMMERCIAL USE
SCH	SCHOOL USE - PUBLIC, PRIVATE, PAROCHIAL, & UNIVERSITIES
SRO	SECONDARY RECOVERY OF OIL
STK	72-12-1 LIVESTOCK WATERING
STO	STORAGE

Office of the State Engineer
Interstate Stream Commission

Use Code	Use Description
SUB	SUBDIVISION
UTL	PUBLIC UTILITY

REFERENCES

61-62

From: Mayerson, David, NMENV
Sent: Tuesday, January 15, 2008 13:22
To: Arfman, Suzan, NMENV
Subject: RE: Wells table

Many more wells than I thought...
Let's try this grouping by the use field:

Consumptive--multiple domestic: MUL, MOB, MDW
Consumptive--single domestic: DOM
Non-consumptive: IND, IRR, SAN, STK
Other: DEW, EXP, MIN, MON, NOT, OBS, PRO, PUB, and blanks

David L. Mayerson
New Mexico Environment Department
Ground Water Quality Bureau
Superfund Oversight Section
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Telephone: (505) 476-3777
Fax: (505) 827-2965
david.mayerson@state.nm.us

From: Arfman, Suzan, NMENV
Sent: Tuesday, January 15, 2008 13:00
To: Mayerson, David, NMENV
Subject: Wells table

David

Here is the "clipped" version of the OSE wells.

As always, enjoy

Mayerson, David, NMENV

From: Arfman, Suzan, NMENV
Sent: Monday, February 11, 2008 10:13
To: Mayerson, David, NMENV
Subject: RE: More information

David...It's always something isn't it. No problem. The info you requested is at hand. I would love to help out with the Bluewater Mill Site. I enjoyed working with you on the SMC project. You should go through Kevin. Let me know what he says. If all goes as planned I should start working on the EPA project in April.

Your data:

Surface Mine <20,000 lbs U308	10
Surface Mine 20,000 – 200,000 lbs U308	5
Surface Mine 200,000 – 2 mil lbs U308	1
Surface & Underground 20,000 – 200,000 lbs U308	6
Surface & Underground 200,000 – 2 mil lbs U308	3
Surface & Underground 2 mil – 20 mil lbs U308	1
Underground Mine <20,000 lbs U308	5
Underground Mine 20,000 – 200,000 lbs U308	15
Underground Mine 200,000 – 2 mil lbs U308	20
Underground Mine 2 mil – 20,000 mil lbs U308	19

Grand Total of 85 mines.

Talk to you soon

Suzan

From: Mayerson, David, NMENV
Sent: Monday, February 11, 2008 9:37 AM
To: Arfman, Suzan, NMENV
Subject: More information

Hi Suzan: Would you be able to run me a count of the number of mines in each of the categories that you plotted? I'm assuming that this should be fairly easy--if not, please let me know.

Also, I was wondering if you might be interested in helping me with graphics for a follow-up report on the Bluewater mill site? At present I'm thinking that I might only need a single map that shows monitor wells on the Bluewater site, as well as domestic wells in the area surrounding (probably using the OSE wells). DOE has a geospatial mapping site--I don't know if you are able to download any data that would be useful for plotting the Bluewater site: http://gems.lm.doe.gov/imf/ext/gems/jsp/launch.jsp. However I'd like to "connect" tables of geochemical data to the various Bluewater well locations. The deadline for this report is several months down the line--I'm thinking June+++, and I'll go through Kevin Bursell if you think you'd like to do this. thanks.

David L. Mayerson
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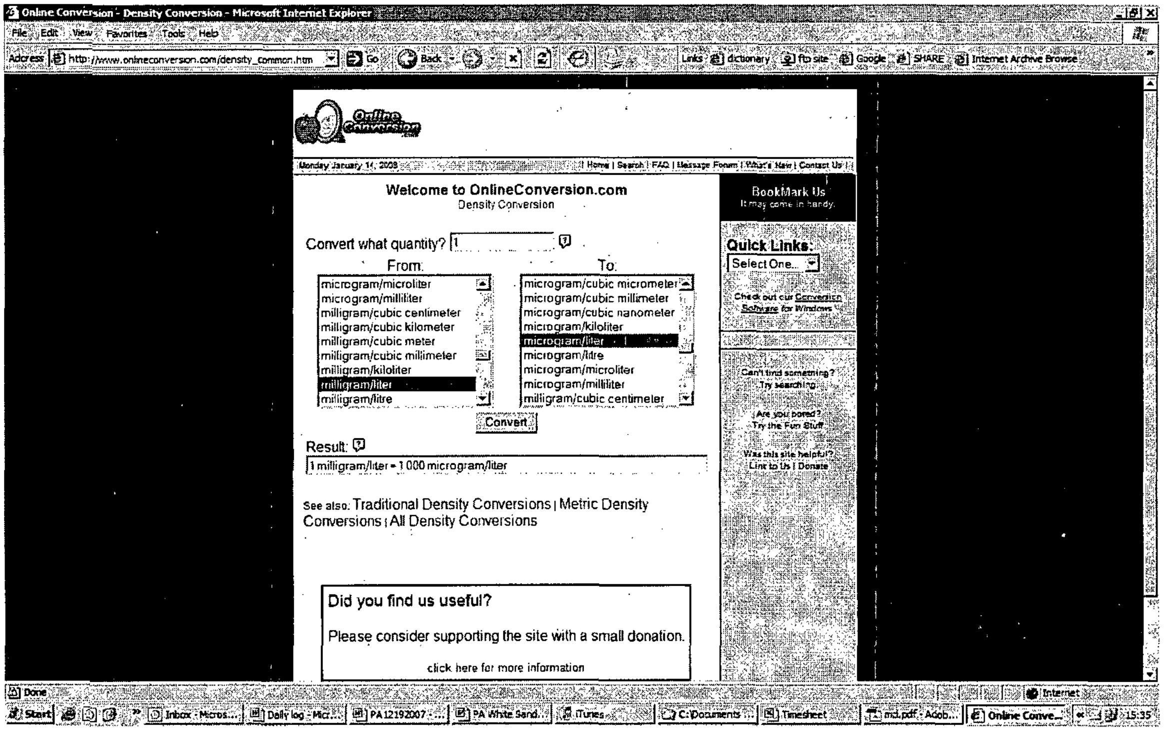
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milligram/cubic meter
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microgram/kiloliter
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